DOES NOT CIRCULATE

UNIVERSITY OF MICHIGAN

JUN 29 1955

MEDICAL LIBRARY

SCIENCE

10 JUNE 1955

VOLUME 121 NUMBER 3154

Freedom, Bondage, and the Welfare State: *H. W. Stunkard* 811

Current Status of Information on the Induction of Mutations by Irradiation: *H. M. Slatis* 817

News and Notes 821

Book Reviews

Millimicrosecond Pulse Techniques; Endemic Goiter; Transactions of the International Astronomical Union; Physical Methods of Organic Chemistry; Decision Processes; Advances in Catalysis and Related Subjects; and Miscellaneous Publications 826

Technical Papers

Improved Hanging-Strip Paper-Electrophoresis Technique: *F. G. Williams, Jr., E. G. Pickels, E. L. Durrum* 829

Use of Narrow Holes for Producing Glow-to-Arc Transitions: *P. L. Copeland* and *B. P. De Lany* 830

Communications

Demonstration of the Basicity of Water in Alcoholic Solutions: *S. Soloway* and *P. Rosen* 832

Effect of Isonicotinic Acid Hydrazide on Some Plant Systems: *A. G. Norman* 834

Use of "Personal Communications" in Scientific Reviews: *D. I. Arnon* 835

Arnold Arboretum Controversy: *T. V. Rankin* 835

Role of Nitrogen Oxides in Formation of Engine Deposits: *R. S. Spindt, C. L. Wolfe, D. R. Stevens* 836

American Dairy Science Association 9A

Meetings & Conferences 14A

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

HANDICAPPED by faulty lab instrumentation?

turn to JAco for instruments that will make your job easier

JAco Console Comparator Microphotometer

New desk height console style with controls arranged for left hand use to free writing hand. Manual coarse motion control and motor driven fine motion with speed approximately 5 microns per sec. Bright image — may be viewed in normally lighted room. Scanning period and distance controlled by foot switch or push button.

JAco-Jones Arithmometer

Performs complete blood counts *automatically* in less than two minutes! Utilizing precision electronic circuits instead of the human eye, the Arithmometer works automatically—you merely insert blood sample, push a button and read results on large dial. 3% accuracy whether you are counting red or white cells. Eliminates "checks", "repeats", and doubt about validity of results.

Why let outmoded instruments — or even lack of proper instruments — stymie your research or production control procedures? Discover how JAco designed-for-the-job equipment can help you do your job more efficiently and at less cost. Write for specific catalogs or describe your procedures and we'll send information on *all* applicable JAco Instruments.

JAco Ebert Spectrograph with Order Sorter

The widely acclaimed JAco Ebert Spectrograph is now available with a new Order Sorter that presents several orders simultaneously at high dispersion, each as an individual spectrum. Dispersion up to 0.18 A/mm, resolution 300,000. Low scattered light, flexible in application, easy to interpret determinations.

Hilger Micro-Focus X-Ray Unit

Wide application in both diffraction and micro-radiography. Features low exposure time, high resolution, and provision for utilization of special techniques. Focal spot diameter is of the order of 0.04mm. Wide range of interchangeable targets. Safety interlock switches eliminate possibility of misuse.

JAco Atomcounter Direct Reading Spectrometer

30,000 line/inch grating gives 5.3 A/mm and excellent intensity over range from 2200 A to 5600 A. Utilizes new patented optical system and electronic circuitry. Performs analysis in 1 minute or less with deviation of only 1-2%. Unitized construction.

SALES OFFICES:

DETROIT
13680 Capitol Ave.

EL CERRITO, CAL.
3344 Devonshire Dr.

PITTSBURGH, PA.
916 Greenhill Rd.

LOS ANGELES (DUARTE)
Miltonwood Rd.

JARRELL-ASH COMPANY
26 Farwell St., Newtonville, Mass.

Freedom, Bondage, and the Welfare State

Horace W. Stunkard

Department of Biology, New York University, New York

THE subject of this article (*1*), is not new; it has been treated by many writers since ancient times and is familiar in certain particulars to all zoologists. It pertains to all kinds of animals, including human ones. To review well-known facts, to examine their implications, and to see how they are related to present-day trends and tendencies is, however, distinctly worth while.

One of the objectives of the AAAS, as set forth in its constitution, is "to improve the effectiveness of science in the promotion of human welfare, and to increase public understanding and appreciation of the importance and promise of the methods of science in human progress." Since zoology is concerned with the facts and principles of animal life, information obtained from the study of other animals is applicable to the human species. In the preface to his textbook, *Animal Biology*, the late Robert H. Wolcott stated (*2*),

> Man, as the highest of animals, can learn by the study of animal life the principles of the most effective living. Every problem concerned with living is essentially a biological problem and capable of analysis and solution by the application of biological principles.

Although the interrelations of human society are more complex than those of lower, or at least simpler, creatures, the fundamental and basic tenets of animal associations, those that are consistently manifest in all groups of animals, may properly be considered in respect to the species, *Homo sapiens*. Certain of these associations and their effects appear so constantly, so regularly, and so universally that conclusions based on them may be accepted as valid.

In the last stanza of his poem, *Die Weltweisen*, Schiller declared that the edifice of the world is maintained by "the impulses of hunger and love. If we translate this poetic expression into more prosaic and mundane terms, the primary and impelling motives in the lives of animals are those concerned with self-preservation and reproduction. The basic necessities of individual existence and racial preservation are food, shelter, and the opportunity for reproduction. All these perquisites are sometimes included in the term *security*, which has been much emphasized in recent years, and which is connoted in the term *welfare state*. It may be applied to any group of organisms and is not intended to refer merely to political entities, although certain implications may be in order.

All animals seek security, as defined, and in those attempts they relinquish certain of their freedoms and become more or less dependent. Concomitantly, they accept certain hazards associated with the loss of freedom. The advantages obtained are offset by coincident dangers and frequently by disastrous consequences. The surrender of freedom is often, perhaps usually, the result of fear, although frequently it is made on promised alleviation of distressing conditions. But the promised advantages are often illusory, and the bondage imposed as a result of dependency is persistent. As an animal or group becomes dependent, recovery of an independent status becomes increasingly difficult. The welfare state—security with contingent subjection and dependency—offers an easy way of life, but it is a slippery path, which by a slow, gradual process leads to loss of integrity, greater bondage, and eventual degradation.

The most conspicuous examples of the welfare state are found among the sedentary, sessile, and parasitic species. All have descended from free-living, independent ancestors. The sessile and sedentary species are largely marine invertebrates of long, if not distinguished, lineage and include the coelenterates, the tubicolous annelids and mollusks, the priapulids, echiurids, sipunculids, the bryozoans and brachiopods, the barnacles, the phoronids, and the tunicates. These animals have diverse ancestries; indeed, most of the phyla have representatives that have adopted an attached mode of life. The parasites comprise a separate category, and this group contains representatives of most of the phyla, although the great majority are found among the protozoans, worms, and arthropods.

The larval stages of most sessile and sedentary organisms are free-swimming, which provides for dispersal of the species; but, after a period of buffeting by the waves, the larva attaches, undergoes metamorphosis, and settles down to a fixed abode. If the location is covered by sand or silt, the supply of food and oxygen is cut off and the animal, unable to migrate to a more favorable site, is subjected to all the hazards of an uncertain tenure. Moreover, with the assumption of a sessile existence, the original form may be greatly modified. Folds of the body wall often secrete a shell, and the original bilateral symmetry may be replaced by a more or less radial one. The cephalic organs undergo regression, together with the nervous and muscular structures concerned with locomotion. New and adaptive structures are developed which compensate for the degenerative changes and enable the animal to survive in the restricted environment. Unable to move about and obtain food, sessile forms become largely filter-feeders, screening organic matter from the water and transporting it to their mouths by ciliary action.

It is well established that the form of any organism is the result of genetic and environmental factors. Its inherent potentialities are determined by its an-

cestry, but the actual realization results from the stimuli to which it is subjected during its developmental period, and from its responses to those stimuli. The ultimate form, therefore, is greatly influenced by the physiological activities of the organism during development. Goodrich (*3*) has aptly expressed the idea in his statement:

> An organism is molded as a result of the interaction between the conditions or stimuli which make up its environment and the factors of inheritance. No single part is completely acquired, or due to inheritance alone. Characters are due to responses, and have been made anew at every generation.

There appears to be a popular notion that the trend of evolution is always onward and upward, but zoologists are aware that this is not true. There have probably been as many retrogressive as progressive changes, and variations often occur in divers and sundry directions, although not entirely at random. Much of evolution is directional, and restrictions on the course of hereditary changes are probably to be found in the architecture of the protoplasm and particularly in its protein components. Orthogenetic tendencies are too strong and too numerous to be dismissed as merely fortuitous or incidental occurrences, and the evidence strongly supports the idea that progressive and retrogressive changes follow somewhat prescribed courses. Much of the mystery of ancient times has been dispelled by the physical and chemical discoveries of the last century, and many of the riddles of living processes are being resolved. Consequently, it is reasonable to believe that in nature things do not happen without cause, although the cause may not be apparent. Mutations, changes in the architecture of the protoplasm, accordingly, must be induced, and their origin must lie in responses to physical or chemical changes that affect the inherent structure of the living material. Selection has undoubtedly been a powerful factor in directing the course of surviving mutations, but it is doubtful whether orthoselection alone can explain all the observed facts. Moreover, selection operates in large part through functional activity. As Eimer (*4*) pointed out long ago:

> Every organism owes its peculiar structure essentially to the use of its parts; nay more, owes its continued existence to this exercise and the unceasing action of external stimuli.

Thus, functional activity and responses to stimuli may account for the appearance and development of similar characters in parallel lines; witness the lophophore in many diverse groups of filter-feeding invertebrates. In general, progressive evolutionary changes are correlated with an active, vigorous type of life, whereas the adoption of sluggish, passive, and inert habits leads to regressive changes in the physiology and structure of animals. It is probable that functional changes antedate and direct morphological ones.

The abandonment of freedom for security is well illustrated in many phyla. Leaving the parasitic forms for later consideration, we find that a survey of free-living groups is instructive. The sponges, Parazoa, are not metazoans in the strict sense but colonial organisms, derived from a choanoflagellate ancestry. Flagellate cells produce water currents that traverse the entire structure and bring in essential food and oxygen. Digestion is intracellular, and simple diffusion provides the metabolic requirements of the individual cells. Organ systems as such are not developed. Such an organization is adequate for sponges, but it is quite incapable of supporting more complex and specialized animals. In development, the stomoblastula undergoes inversion, as in *Volvox*, to form the amphiblastula, which becomes attached to the substrate and transforms into the definitive animal. The radial arrangement of parts in simple sponges is obviously correlated with their sessile mode of life.

The coelenterates, according to the concept elaborated by Haeckel, have long been regarded as the simplest and most primitive of the Metazoa, and the developmental sequence—morula, blastula, gastrula—was accepted as the characteristic phylogenetic pathway. Accordingly, all metazoans were derived from a hypothetical gastrulalike ancestor, and the radial type of symmetry was believed to be more primitive and to antedate bilaterality. Acceptance of such a tenet leaves the origin of bilaterality completely obscure and unexplained. Discussing the origin of the Bilateria, Libbie Hyman (*5*) has stated:

> Since the first Metazoa were almost certainly radial animals, the Bilateria must have sprung from a radial ancestor, and there must have been an alteration from radial to bilateral symmetry. This change constitutes a most difficult gap for phylogeneticists to bridge, and various highly speculative conjectures have been made.

Kowalevski (*6*) advanced the hypothesis, elaborated by Lang (*7*), that the biradial ctenophores serve as a bridge from radial to bilateral types. The idea was based on the morphological similarity between the ctenophores, *Coeloplana* and *Ctenoplana*, and the polyclad turbellarians. But the development of ctenophores is very different from that of the coelenterates; ctenophores have determinate cleavage and mosaic development; the planula stage is lacking, and the larva is a cydippid with ciliated combs. Furthermore, *Coeloplana* and *Ctenoplana* are highly specialized, aberrant ctenophores, a fact that precludes acceptance of the idea that they are intermediate between the coelenterates and truly bilateral animals.

Instead of looking upon the gastrula as a characteristic, phylogenetic stage, Hadzi (*8*) has proposed that the former view be reconsidered. He argued that the coelenterates do not represent a permanent gastrula stage in evolution, that the radially symmetrical structure of the Cnidaria is merely the result of a secondarily acquired habit of sessile life, and that the evolution of the Cnidaria is chiefly regressive. He regarded the planula as the representative of the primitive metazoan and the essentially planulalike Acoela as the simplest of the Turbellaria. He postulated that the Anthozoa, which develop from planula larvae and in some of which (*Edwardsia*) a bilateral symmetry precedes the radial condition, represent the an-

cestral enidarians. Attachment and a sessile mode of life was followed by the segregation of the gonads into a separate, sexual medusoid generation, and an alternation of generations became characteristic in hydrozoan coelenterates. The separation of asexual and sexual generations is common in many groups of invertebrates, and the resemblance of the scyphistoma to the polyp has long been recognized.

If the Kowalevski-Lang theory of descent is reversed, if the coelenterates are actually descended from originally bilateral progenitors, our common *Hydra* is not the primitive creature it has been thought, but the end result of simplification—a hydrozoan—which has lost the medusoid generation. The regressive evolution, if it is confirmed, would be the result of attachment and the sessile mode of life. In his text on invertebrate zoology, Carter (*9*) stated:

> All sessile Metazoa except the coelenterates give clear evidence of being descended from free-living ancestors. We do not know whether the coelenterates are also secondarily sessile, but if not, they stand apart from all other invertebrate Metazoa in this respect.

Among the annelids, the tubicolous and burrowing forms comprise a large assemblage of vermiform animals that have sought security by withdrawal into secluded retreats. Comparison with more active, related species shows that the physiological and morphological changes undergone by these tubicolous species are correlated with, and have undoubtedly resulted from, restriction, temporary or permanent, within the confines of a narrow tube or burrow. The body tends to become cylindrical, and the exposed parts develop a radial symmetry. In the terebellids, serpulids, and sabellids, the peristomium forms a collar which bears grooved tentacles that subserve the functions of sensation, respiration, and food collection. Cilia produce water currents which bring food and oxygen, and filter-feeding is typical in this group of organisms. In burrowing forms, *Arenicola* and the earthworm, there is a reduction in cephalic structures, food is taken from the vast amount of soil or detritus that passes through the alimentary canal, and in *Arenicola* the eversible pharynx becomes an efficient organ of locomotion. Among these polychaetes there is progressive loss of metamerism, of parapodia and chaetae; with breakdown of the vascular system and the formation of hemocoelic sinuses; and corresponding modification of the excretory structures. In the archiannelids, originally regarded as primitive, as the name implies, but more probably retrogressive polychaetes, there is undoubted evidence of reduction and simplification. In this group, juvenile polychaete characters are retained, for example, ciliation, epidermal nervous system, and protonephridia. The number of somites, the coelom, and the musculature are reduced, with more or less complete disappearance of the mesenteries and vascular system.

In the more specialized annelids, included in the Gephyrea, which live in the mud and superficially resemble holothurians, the coelom is spacious, but metamerism is partly or completely lost. *Echiurus* has a trochophorelike larva in which several pairs of mesoblastic somites may be recognized, but they undergo regression and are absent in the adult, which is characterized by a large, spatulate prostomium and the presence of a single pair of chaetae. In another echiurid, *Bonellia*, the proboscis of the female is greatly elongated, bifid terminally, and retractile, while the males are dwarf, ciliated creatures, consisting essentially of excretory and reproductive organs, which live parasitically in the segmental organ of the female. The larva has no coelom or segmentation, and the body cavity of the female is formed by the coalescence of spaces in the mesoderm. There is no trace of segmentation in the larva of *Sipunculus*; the adult has no prostomium, but the anterior end of the body is protrusible and retractile. The nephridia are reduced to one pair, and the ventral side of the body is protruded and so elongated that the anus is dorsal and anterior, a condition similar to that in the phoronids and bryozoans.

The Mollusca exhibit great diversity of structure, correlated with their bionomic relations and especially with feeding habits and type of food. The phytophagous species have well-developed radulae, absent in others; the cephalopods and many gastropods are predacious; a few gastropods are parasitic; and the lamellibranchs feed on minute organisms suspended in the water. Except for the cephalopods, most mollusks are sluggish, attached or hidden forms, with obviously regressive modifications. The absence of metamerism, reduction of the coelom to the pericardium and cavities of the gonads, breakdown of the blood vessels and formation of a hemocoele, and the diversity of respiratory organs, ctenidia, mantle or lungs, all testify to the degraded condition of the mollusks. The tubicolous and burrowing species manifest further retrogressive changes, with special adaptations for their restricted mode of life. The lamellibranchs lack eyes, tentacles, and radula; the clam has lost its head; the oyster has lost not only the head but also the foot and the anterior adductor muscle. Cuvier included the bivalves in his group, Acephala, which contained also the brachiopods, barnacles, and tunicates. The term, *headless*, is not inappropriate for these animals, all of which have renounced freedom for security.

The successive stages in the life-history of the sessile crustaceans, notably the barnacles, portray the scenes in the evolutionary drama and exhibit the regressive changes that follow the surrender of freedom. They begin life as free-swimming nauplii, with median eyes, inverted as in the vertebrates, with uniramous antennules and biramous antennae and mandibles. The early molts of the cirripedian larvae result in only slight changes in morphology. A major change then gives rise to a stage in which the animals resemble *Cypris*, a common genus of the class Ostracoda. The body is now enclosed in a bivalve shell, the antennae have disappeared, and the antennules have attachment disks on which cement glands open. In the common barnacles, there are six pairs of thoracic appendages and a small abdomen with four somites. This larva

attaches by the disks on the antennules, and metamorphosis is completed. The preoral region enlarges and serves for attachment; the mantle secretes the shell plates; the abdomen disappears; the central nervous system consists of a subesophageal ganglion and separate ganglia for each pair of cirri behind the first; there is no brain; and the body rotates so that the ventral side is exposed. In the reduction and disappearance of the coelom, in the absence of a brain, and in the rotation of the body, so that it comes to occupy a position at right angles to the original antero-posterior axis, the barnacles agree with the bryozoans. This morphological agreement has no genetic basis; it is not homologous but is the end result of an attached mode of life in both groups.

There is a heterogeneous assemblage, often listed as the minor coelomate phyla or as groups of uncertain systematic position. They have persisted, although in diminished numbers, since early geologic eras and may comprise surviving relicts of a primitive, trimetameric, ancestral stock. With the exception of the chaetognaths, they are sessile or sedentary animals and include the bryozoans, brachiopods, and phoronids. In many respects, larvae of the last-named groups resemble those of the echinoderms and prochordates. In all these forms, the coelom, when present, arises as evaginations from the digestive tract and, especially in the early stages, three metameres are often indicated. After attachment of the larvae, profound metamorphic changes replace the original organization with one adapted to the new mode of life. Their systematic relations, therefore, can best be determined by study of their larval stages, but the larvae also are greatly modified; among the Bryozoa, only the larvae of the endoprocts and the shelled Cyphonautes larva of the ectoprocts have functional digestive tracts.

Although the early developmental and larval stages provide the best evidence of systematic relations among animals that are profoundly altered at metamorphosis, the use of larval stages for taxonomic and phylogenetic determinations requires caution and discernment. As was noted by Leuckart more than a century ago, larvae are merely feeding and dispersal stages, adapted to provide for the earlier independence of the progeny, which are thus able immediately to carry on a free-living existence and so to increase the reproductive capacity of the species. This early independence of the young individuals has resulted in the development of adaptive, coenogenetic features, which have no phylogenetic significance. The older idea of recapitulation, that the individual in its life-cycle repeats briefly the ancestral history of the race, has largely been replaced by a more rational and plausible one, namely, that embryos and larvae do not correspond to adult ancestors but to their developmental stages. Accordingly, emphasis has shifted to a study of comparable developmental stages, to axial relations, cleavage patterns, symmetry, and inherent structural details of larval types.

Larvae of related groups show greater resemblance than do the adults, and the resemblances are greater, the earlier the developmental stage. Since larvae become adapted for their own survival and growth, there must be a structural reorganization when the animal transforms to the adult stage which has a different mode of life. The change may be gradual if the larval organs can develop directly into adult ones; otherwise there must be a more or less complete metamorphosis, in which larval structures are resorbed and adult ones are formed by new growth from imaginal buds or other centers of embryonic cells. Such change is witnessed when the bilateral, pelagic larvae of echinoderms attach and transform into radial creatures. In sedentary, mud-living species, the change is less dramatic, and the transformation of the Actinotrocha larva of *Phoronis* recalls the condition in the similarly sedentary sipunculids—enlargement and protrusion of the ventral side of the body until the animal becomes vermiform, with the viscera enclosed in the abdominal extension and the anus turned so far forward that it comes to lie near the mouth.

The agreement in general morphology between the fresh-water ectoprocts and the phoronids and among the Actinotrocha, Tornaria, and echinoderm larvae strongly suggest genetic relationships. These resemblances can be explained on only one of two hypotheses: either (i) parallel evolution—that is, convergence and adaptation to similar habits—has occurred, or (ii) the organisms must have evolved from a group that at some time had larvae of similar structure. Resemblances between these invertebrate larvae are too numerous and too detailed to justify acceptance of the first alternative. On the other hand, if the groups with similar larvae are genetically related, it follows that the adaptive changes in existing groups have resulted from different modes of life, adopted by descendants of the original group. The absence of a coelomic cavity in the endoproct bryozoans may be primitive and they may be related to the lower invertebrates, but their agreement otherwise with the ectoprocts strongly suggests genetic relationship. In endoprocts, the persistence of larval features, the presence of protonephridia, and absence of coelom may indicate pedogenesis, or the coelom may have undergone reduction, as in the archiannelids and mollusks, with ultimate disappearance. The ectoprocts, on the other hand, using the coelomic fluid for operation of the lophophore and tentacles, have retained the body cavity without metamerism, although the excretory organs have been lost.

It is possible that the prochordates may be derived from the same trimetameric stock. In *Balanoglossus* and *Amphioxus*, as in the echinoderms, the coelom arises as enterocoelic pouches which form three primary segments. They are retained throughout life in the Enteropneusta, whereas in the Cephalochordata the second forms the oral somite and the third gives rise to all the postoral mesoderm. *Amphioxus* remains free-swimming, possibly like the chaetognaths as a sexually mature larva, whereas the other prochordates undergo metamorphosis. The Enteropneusta become burrowing, vermiform creatures; whereas the Tunicata comprise a group, predominantly sessile, of retro-

gressive, sluggish, shapeless forms without coelom, segmentation, or nephridia; with degenerate sense organs and nervous systems; and enclosed in protective tests. In the ascidians, the attached habit results in the formation of a U-shaped digestive tract, a situation analogous to that in *Phoronis* and the sipunculids. So, among the prochordates as in other groups, the sessile habit has led to regressive changes, the original features have been obscured or lost completely, and these animals afford further striking evidence that stepwise loss of freedom has resulted in corresponding retrogression and degeneracy.

Loss of freedom, individual bondage, and the evolution of the welfare state are characteristic features of the social insects. According to Wheeler (*10*), in the last 50 to 100 million years, 24 different societies, each with its own particular features, have arisen in as many different families of insects, representing "Nature's most startling efforts in communal organization." At first glance, the colony appears to be a busy, efficient, happy family, with members contributing maximal effort to the welfare of the group.

Information is probably most complete concerning the common formicid ants and the honeybee. The industry of the ant is proverbial (*11*):

> Go to the ant, thou sluggard; consider her ways and be wise; Which having no guide, overseer or ruler, Provideth her meat in the summer, and gathereth her food in the harvest.

But closer examination of social organization among ants reveals that with the evolution of the "welfare state," there is developed a rigid, rigorous caste system, in which individuals are bound to permanent, monotonous conditions of servitude. The royal individuals perform the sexual, reproductive functions but otherwise lead a life of regal ease, while the other members of the colony belong to one or another of the sterile "worker" castes. There may be various types of workers; some cultivate a fungus, others tend the aphids, "the dairy-cattle of the ants" according to Linnaeus; others are soldiers; and among the honey ants, certain individuals serve as "storage tanks" for honeydew. These latter members are stuffed until their bodies are enormously increased in size, almost spherical; they are quite unable to walk and they hang by their claws from the ceilings of the nest-chambers, giving out nourishment to other members of the colony during periods when food is scarce. Under the surface of the apparently serene tranquility of the ant colony, the most savage and pitiless events are taking place; murder, regicide, pillage, and forays against other colonies in which the adults are killed and the larvae and pupae are carried off to slavery.

The honeybee has been extolled in song and story, even deified, as a virtuous, sedulous, and praiseworthy example of social efficiency. In reality, it is a most pathetic little creature. Restricted during development to such an inadequate diet that its reproductive organs remain rudimentary, without hope of romance or progeny, it burns itself out and dies exhausted after a few weeks of feverish activity, a martyr, and victim of the "welfare state."

But it is in the realm of animal parasites that the most conspicuous results of dependency are encountered. Swellengrebel (*12*) defined a parasite as "an organism wholly dependent on another living organism for its food, its shelter and its reproduction." Note the word *dependent* in the definition. Parasitism is an almost universal phenomenon in the animal kingdom, and it is important to inquire into its origin, extent, and effects. It has long been recognized that parasites have been derived from free-living progenitors. Moreover, it is certain that parasitic lines have developed repeatedly, and at various times, in most of the several phyla, from protozoans to arthropods. In any community, and the earliest ones must have been aquatic, numerous kinds of plants and animals live together, and parasitism is an outgrowth of such association. Animals in the same habitat strive for sustenance, for survival. They seek food, shelter, escape from predators, and opportunity for reproduction.

It may have been accidental or incidental that certain animals found it expedient to attach themselves on or in the bodies of other animals. But acquisition of a host was the first step in the direction of parasitism. In certain instances, fear may have incited the animal to seek shelter; in other instances the secretions or excretions of the host may have afforded nourishment, and hunger may have impelled the association. Or the animal may have been ingested accidentally, and in the digestive tract of the host found conditions suitable for survival. But gradually, the incipient parasite became more and more dependent. When other food sources were insufficient, what would be easier than to feed upon the tissues of the host? The dependent animal is proverbially looking for the easy way. So parasitism involves a gradual and progressive adaptation to a dependent condition on the part of the animal or species that adopts this mode of life. With protection and food supplied abundantly by the host, the parasite enjoys a condition of luxurious idleness. With nothing else to do, its surplus energy finds expression in enormously increased reproduction.

The parasite no longer has to seek food or protection from enemies; it can relax in comfort; the welfare state has been attained. But cessation of an active existence results in characteristic changes in the physiology and morphology of the parasite; the organs that function most vigorously in a free-living existence, which render a species most alert and active, are no longer used and undergo progressive reduction and eventual atrophy. Especially is this true of the sensory and locomotor organs. The parasitic flatworms have lost their cilia; fleas and lice have lost their wings, the scab mites lack eyes and organs of respiration; while the linguatulids are so highly modified that they have lost practically all their primitive characters and superficially resemble tapeworms. With degeneration of the sense organs and muscles, there is a corresponding reduction in the nervous system. As parasitic regression proceeds, one after another of the organ systems suffers a reduction and may eventually disappear. Certain groups, of which the ces-

todes, acanthocephalans, and monstrillid copepods are conspicuous examples, have lost all traces of an alimentary tract. With the disappearance of the digestive system, the animal has lost the ability to ingest and digest food and is reduced to a saprozoic type of nutrition.

Although less conspicuous, the physiological losses resulting from parasitism are far more important than the morphological ones. The obligate parasite has lost the ability in the absence of other living cells to carry on anabolic phases of metabolism, to synthesize protein, or to grow. It is clear that the enzymes concerned in anabolic processes must be supplied by living cells of the host or other associated organisms. This inability to carry on constructive metabolism, except when supplied with enzymes or coenzymes from extraneous sources, has stymied attempts to culture parasitic organisms *in vitro* and is largely responsible for our present ignorance of the physiology of animal parasites.

While certain organ systems undergo reduction in parasitic species, there is a compensatory increase in reproductive capacity. Luxurious idleness with abundant nourishment supports an active metabolism that finds expression in enormously increased reproductive activity. Protozoa may multiply in the host to reach appalling numbers. A malarial patient with 1 percent of the red cells infected would have approximately 200 million parasites in his body. In metazoan species there is a corresponding overdevelopment of the sexual organs. The number of ova produced by parasitic worms is stupendous. The average daily output of eggs by a mature female of *Ascaris lumbricoides* is about 200,000; of *Ancylostoma duodenale* some 25,000. A specimen of *Fasciolopsis buskii* produces about 25,000 eggs per day and one of *Taenia saginata* about 1 million. This cestode grows 10 to 15 proglottids each day, and each proglottid contains about 100,000 ova. Moreover in parasitic species, new and accessory methods of reproduction increase the number of progeny. Among the Sporozoa, binary fission is replaced by multiple fission; schizogony alternates with sporogony, and the two cycles frequently involve different host species. In the digenetic trematodes, the sexual generation is followed by asexual generations, where polyembryony increases the number of progeny, often several thousandfold. Strobilization in cestodes may be regarded as a form of asexual reproduction. This profuse and unrestrained reproduction is essential, since it is necessary to compensate for the mortality of young stages of the parasites.

Among parasitic species, the offspring, in the form of cysts, or eggs, or larvae, typically emerge from the host and constitute the infective stages that transmit the parasites to new hosts. These dispersal stages, as a rule, are delicate and short lived, and most of them succumb to the hazards of finding the next host. In many instances, not more than one in a million actually succeeds in completing the life-cycle. In a balanced condition of nature, the reproductive capacity of any species just equals the losses occasioned by death. But the parasite is not concerned with the welfare of the offspring. It lives an entirely selfish existence, and in the welfare state the comfort and security of the existing generation is often maintained and enhanced by mortgaging the future of succeeding generations.

It should be remembered that parasites, being wholly dependent, can survive only so long as they can find other organisms to support them. They contribute nothing of value, their effects are definitely deleterious, and the defense mechanisms of the host are eventually mobilized against them. So, despite the apparent ease and luxury of parasitic existence, the probability of success in such a venture is exceedingly small. Such a welfare state exists only for those lucky individuals, the favored few, who are able to cajole or compel others to provide the welfare.

The survey just made shows that throughout the animal kingdom, during human history as recorded in written form and during geologic history as recorded in the evolutionary record, independence, with freedom to explore new vistas, has been the essential condition of progress, whereas the surrender of freedom in an attempt to attain security has led to bondage, regression, and degeneracy. The welfare state offers security to workers on terms of contingent subjection and dependency, but such a social order reduces the individual to abject subservience, and results in the development of a rigid caste system. Dependency and degeneration are cognate phenomena, they go hand in hand; either may be the causative agent, and it is often difficult to determine whether, in any particular instance, creatures became degenerate because they were dependent, or became dependent because they were degenerate. In any event, the well-worn attempt to obtain comfort without effort, to get something for nothing, persists as one of the illusions that in all ages has intrigued and misled the unwary.

References and Notes

1. Based on the author's address as vice president and chairman of Section F of the AAAS and president of the Society of Systematic Zoology on 30 Dec. 1954 in Berkeley, Calif.
2. R. H. Wolcott, *Animal Biology* (McGraw-Hill, New York, 1933).
3. E. S. Goodrich, *Studies on the Structure and Development of the Vertebrates* (Macmillan, London, 1930).
4. G. H. Th. Eimer, *Die Entstehung der Arten auf Grund von Vererben erworbener Eigenschaften nach den Gesetzen organischen Wachsens* (Jena, 1888).
5. L. H. Hyman, *The Invertebrates II: The Acoelomate Bilateria* (McGraw-Hill, New York, 1951).
6. A. Kowalevski, "Verhandlungen der zoologischen Section der VI: Versammlung russischer Naturforscher und Ärzte," *Zool. Anz.* **3**, 140 (1880).
7. A. Lang, "Der Bau von *Gunda segmentata* und die Verwandschaft der Plathelminthen mit Coelenteraten und Hirudineen," *Mitt. Zool. Stat. Neapel* **3** (1884).
8. J. Hadzi, "An attempt to reconstruct the system of animal classification." *System. Zool.* **2**, 145 (1953).
9. G. S. Carter, *A General Zoology of the Invertebrates* (Sidgwick and Jackson, London, 1946).
10. W. M. Wheeler, *Social Life Among the Insects* (Harcourt, Brace, New York, 1923).
11. Proverbs, 6: 6–8.
12. N. H. Swellengrebel, "The efficient parasite." *Proc. III Intern. Congr. Microbiol.*, pp. 119–127.

Current Status of Information on the Induction of Mutations by Irradiation

Herman M. Slatis*
McGill University, Montreal, Canada

IN order to understand the effect of irradiation on man's genes, it is necessary to have information that is not available at present and that, to some extent, may never be collected. However, there are several ways of estimating the magnitude of the inheritable bad effects that are caused by irradiation. Evans (*1*) divided a value that represented the average spontaneous mutation rate per generation at an average locus in man, 10^{-6}, by the estimated rate at which x-rays produce new mutations per roentgen (r) at the average locus, 3×10^{-8}. This gave a value of 300 r as the amount of irradiation that would double the spontaneous mutation rate. On the basis of this figure, Evans suggested that even if a few people were to receive relatively large doses of irradiation, it would not be of much effect in producing defects either in their children or in their remote descendants. Wright (*2*) has pointed out that Evans' estimate of the spontaneous mutation rate is likely to be far too high. By recalculating with the spontaneous mutation rate at one one-hundredth of that used by Evans, Wright found the effect of irradiation to be relatively great when it was compared with the spontaneous mutation rate.

Even if we could make an accurate estimate of the average mutation rate in man, this method would give an answer only *relative* to man's present genetic status. An evaluation of the absolute amount of radiation-induced genetic damage is dependent upon the estimation or knowledge of other facts, such as the manner of action of deleterious genes and the number of loci in man. Evans assumed (when he was discussing certain problems) that there are 10^5 loci, that 2.5×10^{-6} of all genes mutate to deleterious recessives each generation, and that there is an accumulation of 50 times as many mutants as occur each generation. These conditions would result in an average of one new deleterious mutant for every two persons, and the total accumulation of these mutants would be about 25 per person. Since it is known that brother-sister matings occur occasionally and since these appear to give normal children in most cases, an estimate of the number of mutants existing in man must not make this sort of child a too unlikely possibility. However, if there are about 25 deleterious recessive mutants per person, which would mean about 50 per married couple, then one-fourth of these, or about 12, would be present in both a brother and a sister. The chance that one of their offspring would not have any of these deleterious recessives in homozygous condition would be $(\frac{3}{4})^{12}$, or about 0.03. This is a far too small value to fit the facts and indicates that the assumptions made are not completely valid. Larger estimates of the number of deleterious mutants in man, such as the value of 60 suggested by Muller (*3*, p. 351), are obviously too high.

This article attempts to assess the effect of irradiation on man's genes by estimating the limits within which various pertinent values lie. These limiting values are then combined to give maximal and minimal estimates of the effect of irradiation on man. However, these estimates are constrained to reasonable values by reference to relevant observations.

Mutant loci in man. Man cannot be very different from any other mammal in factors such as gene number and the mechanics of gene action. It is known that mammals can be taken from large interbreeding populations and be bred in captivity from the progeny of a single pair, which indicates that individuals of these species are not carrying large numbers of deleterious recessive mutants. By extension from other mammals to man, it would appear that there is confirmation for the assumption that we are not carrying large numbers of deleterious recessives.

Within historical times, except in a small number of communities, man has probably kept matings between closely related persons sufficiently rare and matings with members outside the local in-group sufficiently frequent to warrant assuming at least a moderately large population size. In this case the deleterious mutants observed in man would occur at stable gene frequencies. By working with a small sample of first-cousin marriages, I estimated (*4*) that the average person is carrying only eight abnormal recessive genes. The term *abnormal* includes some genes that do not have an effect on viability and that may be balanced by genes that were not detected because they are lethal early in gestation. The number of deleterious mutants carried in the heterozygous state by the average person will be referred to as A. An estimate of A based on the observation of the children of related individuals approximates a total value, whether the genes are completely recessive or whether they have some effect in the heterozygous state. Since few genes (if any) are known to have an unfavorable effect in the heterozygous condition without being far more debilitating when they are homozygous, the average number of deleterious genes, whether simple recessives or partial dominants, cannot be very large.

Limits. We may choose the limits of 4 and 12 as bounding a reasonable estimate of A in man.

Whether the mutants at a locus cause death even

before birth or whether they do not affect the life-span but cause the individual to be sterile, the selective effect is roughly the same, for the frequency of the gene will be lowered in either case. A mutant that has a less-than-normal likelihood of being transmitted by a homozygous individual may be referred to as a *lethal* (I use this term in a broader sense than is usual). The processes of human society modify the lethality of many genes; for the purposes of this paper we assume that the sum of these modifications is about zero with respect to changes of gene frequency. If a lethal is not always effective, some of its homozygotes will be part of the breeding population. If the homozygotes leave very few offspring and are classed as lethal, or if they leave almost a normal number of offspring and are classed as viable, there will be little effect on our calculations. Mutants that reduce reproductive capacity to an intermediate value will bias calculations based on the assumption that all recessive lethals are fully efficient. The amount and direction of this bias is dependent upon the number of such mutants, their relative lethality, the proportion of them that is detected, and similar considerations. Our knowledge of such mutants is limited; for the purposes of this paper we must assume that they are sufficiently rare to have little influence on the calculations. Our estimate of A should be restricted to those deleterious mutants that have a strongly lethal tendency.

It would appear that some loci are not necessary for the life of an animal, for some viable *Drosophila* are homozygous for losses of genetic material. However, since almost all genetic losses that fail to kill homozygotes are so small that we can suspect them of being limited to a single gene, most genes appear to be necessary for life. If a gene is necessary for life, it will have mutant alleles that are lethal, even though the most frequent mutant form at the locus may be viable. Loci that do not form lethal mutants may affect appearance or physiology but not enough to cause death. *Limits.* It is reasonable to assume that at least 0.75 of all loci can form mutants that are lethal when homozygous.

The total number of loci in man is unknown, even the order of magnitude. It is generally agreed that there is evidence for assuming 5000 to 10,000 as the number of loci in *Drosophila*, and most students of the subject suggest that man's greater complexity requires that he have more genes than the fruit fly has. *Limits.* There is no particular reason to believe that 5000 loci are too few for man. An estimate of 100,000 loci is well above the maximum number usually proposed.

Spontaneous mutation rate in man. A number of recent papers have contained calculations of the mutation rate of various human loci and these have been toward the values of 10^{-4} or 10^{-5} per generation (*5*). However, the highest of these rates is probably in error, because the selection that seems to occur in favor of heterozygotes (*6, 7*) was neglected; and some of these rates may be questioned as being too high on other genetic grounds (*8*). Moreover, since the mutation rate is not calculated unless a condition is relatively common, these rates may be selected because they are particularly high (*2*).

Let us define a value v as the average rate at which mutations to deleterious alleles occur at the N loci capable of having such mutations. The mutation pressure, which is continually forming these alleles from the normal, will be balanced by selection at the frequency $\sqrt{v}$, which is known as the equilibrium frequency. If the population is in equilibrium, $A = N\sqrt{v}$. Unfortunately, if there is a wide variety of mutation rates this formula will not hold, for it assumes that v is the same for all loci. With just a small number of highly mutable loci the true value of v will be much higher than would be calculated from this formula. For example, given 10 recessive lethal loci, if one locus mutates to a recessive allele at a rate of 9.01×10^{-6} and nine each mutate at 0.11×10^{-6}, the average mutation rate will be 1×10^{-6}. The high-mutating locus would have a mutant equilibrium frequency in the population, $\sqrt{v}$, of 3×10^{-3}, and each of the low-mutating loci would have a mutant frequency of 0.33×10^{-3}. The total frequency of mutant alleles in this population would be 6×10^{-3}. If each of 10 loci had the same mutation rate, a total frequency of mutants at 6×10^{-3} would mean that each had a frequency of 6×10^{-4} and a mutation rate of 3.6×10^{-7}. This is only about one-third of that calculated for loci with differing mutation rates. *Limits.* It seems reasonable that if A and N are estimated, the apparent value of v will be between one-half and one-tenth of its true value.

Stern *et al.* (*9*) reported for *Drosophila* that a number of recessive lethals have a slight-to-moderate lethality in the heterozygous state. One may interpret their results as indicating that about one-third of the mutants are lethal to some heterozygotes (Stern *et al.* would replace "one-third" by "most"). The proportion of *Drosophila* mutants that has a deleterious effect on the heterozygotes is probably a bit greater than this, for the chance of finding a mutant that has a lethal effect on one-fourth of all heterozygotes is only three-fourths as great as the chance of finding a mutant that does not affect the viability of heterozygotes.

Muller (*10*) has discussed the possibility that there are many semidominant lethals in man and has referred to the work of Levit (*11*), who suggested that a number of man's ailments are inherited as poorly penetrant dominants. These human semidominants might have little selective effect, because they often act after the peak of the reproductive period. In *Drosophila*, the trial of metamorphosis may be an important factor in the youthful susceptibility of the species to heterozygous lethals, so that lethals may not be as deleterious to the heterozygote in man as they are in *Drosophila*. Statistically, the difference between assuming that genes are recessive in heterozygotes and that they are partially dominant is that the mutation rate must be higher in the latter case to

support a given equilibrium frequency. If the average human being carried as many as eight or 10 deleterious mutants in the heterozygous state, and if a moderately high proportion of these mutants were detectable as incompletely penetrant dominants that act before about the age of 50 years, then much larger numbers of them than are known should have been found by now.

The lethality that is caused by a gene may be denoted by the symbol s, the selective disadvantage. The value of s is 1.0 for lethal recessive genes and is omitted from formulas; for semidominant lethals, s equals the proportion of heterozygotes that are selected against because they carry the gene. *Limits.* It is reasonable to assume that the limits of the proportion of deleterious recessive genes that has some effect in the heterozygote are 0 and 0.30. Such genes cannot average more than 10 percent mortality among the heterozygous carriers by the age of parenthood.

Radiation-induced mutation rate. Although radiation-induced mutation rates have usually been studied only in mature sperm, the rate in oogonia and spermatogonia is the only value of practical importance, because of the short life-span of all other stages. Russell (*12*) tested mice for spermatogonial mutants at seven loci and found an average mutation rate of 2.5×10^{-7}/r. (This type of estimate is not subject to the error discussed in the preceding section and need not be corrected for differences in mutation rates.) Unfortunately, Russell's result does not accurately represent an over-all average, because the numbers of mutants at the various loci indicate that they mutate at widely differing rates. A choice of different loci might have resulted in a far different average rate. Moreover, a criterion for choosing these loci was that Russell already possessed a viable recessive mutant for each, which might have selected against loci with low mutation rates.

Isoalleles are minor differences from the standard form of the gene that can be detected only by special techniques, although some of them might have been found by Russell because of the methods that he has employed (*13*). Even if isoalleles are frequently formed, they are, by definition, of little importance to the vitality of the individual. On the whole, the mutations found by Russell do not include isoalleles but probably indicate the mutation rate toward the physiologically important alleles that would form at any locus. *Limits.* These data of Russell's indicate that the average induced mutation rate per locus is probably between 1×10^{-6} and 2×10^{-8}/r in the mouse, and it is reasonable to assume that this also describes the limits of the range for man.

Estimates of man's genetic make-up. Limits for a number of factors have been suggested in the foregoing sections. The major limiting condition is the observation that the average man is not carrying a large number of recessive and semidominant lethal genes. If the average number of deleterious mutants in man is as few as four, then either the mutation rate must be small or the number of loci must be small. If there are as many as 12 deleterious mutants, the mutation rate and the number of loci might be greater.

For a population in equilibrium, radiation damage will be least effective if the value of A is very high, the loci differ greatly but have a high average spontaneous mutation rate, and the number of loci at which mutants contribute to A is small. Choosing the limiting values at this end of the scale, the number of deleterious recessives (A) carried heterozygously in the average man is 12; there are about 5000 loci, of which only 0.75 can have lethal alleles; about 0.30 of the lethal loci are semidominant, killing 0.10 of the heterozygotes; and the mutation rate differs so greatly from locus to locus that the apparent value of v will be about one-tenth of the true value. With these figures, the number of loci at which lethals can occur is 3750. Of these, 2625 (N_1) will be recessive lethals and 1125 (N_2) will be semidominant lethals ($s = 0.1$). The apparent value of v can be calculated from $A = N_1\sqrt{v} + N_2 v/s$. This formula is solved with $\sqrt{v}$ equal to 0.0045 and v equal to 2.0×10^{-5}. The true rate of v might be about 2×10^{-4}.

This value is greater than was considered likely to be the rate of mutation in man. Small changes in some of the contributing factors might bring down the true value of v to 2×10^{-5}, which is probably still too high but not unreasonable. Reductions in the proportion of loci that are semidominant and in the ratio between the true and the apparent values of v are particularly indicated.

If we assume the lowest reasonable average rate of induced mutation, 2×10^{-8}/r, then 1 r of irradiation will induce only one one-thousandth as many mutations as occur spontaneously. To double the spontaneous mutation rate, gonads would have to be exposed to 1000 r. However, Russell's (*12*) controls clearly showed a low spontaneous mutation rate compared with the many mutations produced by irradiation. Animals irradiated with 600 r showed more than 20 times as many mutations as the controls. Allowing for the small numbers involved, the minimum effectiveness of 600 r is at least 6 times the spontaneous rate, and 100 r is the upper limit of the irradiation dose that doubles the spontaneous mutation rate. Therefore, estimates of the spontaneous and the radiation-induced mutation rates must not differ by a ratio of more than 100 : 1. With only 3750 sensitive loci, the average number of radiation-induced mutations per germ cell for an exposure of 100 r would be about 0.075, or about one in every 13 germ cells, if mutations are induced at an average rate of 2×10^{-7}/r. Thus, even this large dose of irradiation would have little effect on subsequent generations. Alternatively, if the natural irradiation received by the population of the earth were increased to the extent of adding an average of 1 r by the time that parenthood is achieved, new deleterious mutants would occur only once in every 1333 gametes. In either of these cases the damage to subsequent generations must be quite low and will not be important when it is compared

with the spontaneously occurring mutations in the population as a whole.

The data of Hertwig, as compiled by Russell (*12*), suggest that the sum of all lethal mutations at all loci in mice is as low as 6×10^{-6}/r for each gamete, or some value up to about 10 times this frequency. Even at 6×10^{-5} mutations/r there would be only one lethal in every 16,000 gametes after 1 r of irradiation, which is a lower rate than the lowest estimated here. It is possible that the discrepancy between Hertwig's data and the values calculated in this paper is the result of the small number of observations made by Hertwig.

The estimate of the maximum effectiveness of radiation damage is also affected by certain limiting factors. Natural radiation yields at least 3 r within 30 years (*1*), and it may yield 17.5 r during this period of time (*3*, p. 475). Taking the lesser of these rates, the maximum radiation-induced mutation rate per roentgen cannot be more than one-third of the spontaneous mutation rate (if other factors contribute to spontaneous mutation, it would be lower). If the radiation-induced rate is as high as 1×10^{-6}, the true spontaneous rate would be at least 3×10^{-6}. The apparent spontaneous rate might be as high as half of this, or 1.5×10^{-6}, and $\sqrt{v}$ would be 1.2×10^{-3}. N_1 would be about 3300 if A is equal to 4, and N_2 would constitute 0.30 of all deleterious mutants if 1600 semidominants exist. These 4900 sensitive loci would yield an average of 0.0049 mutations/r for each gamete, or about one mutant in every 200 gametes. A proportional decrease in the radiation-induced and spontaneous mutation rates would permit increased estimates of N but would result in even smaller proportions of the gametes carrying new mutations. However, an increase of A to a value as high as 12 would increase the size of N to 15,000, and after 1 r of irradiation the frequency of gametes carrying newly induced mutants would be about one in 70. There would be an increase in the amount of damage caused by irradiation, but no change would occur in the relative effectiveness of spontaneous and induced mutation. An irradiation dose of about 400 r (independently of the value of A) would be enough to increase the number of deleterious genes in each of the offspring of the irradiated person by 50 percent, and the number of deleterious genes carried in each gamete would be doubled. The assumption that almost one-third of all mutations have a semidominant lethality would mean that some of the immediate descendants of a heavily irradiated person would have a distinct likelihood of being impaired or killed because of the irradiation.

Conclusions. The present genetic status of man is that he probably is carrying a few deleterious mutants and that mutation is transforming more normal genes to abnormal ones at about the same rate that selection is causing abnormals to be lost. Many mutations are lethal and, if man-made irradiation increases the mutation rate, the result is sure to be deleterious. However, the radiation-induced mutation rate per roentgen seems to be bounded at between one-third and one one-hundredth of the spontaneous rate, and the spontaneous rate does not appear to be as high as some authors have recently suggested.

In terms of the absolute amount of damage done, as little as 1 r of irradiation may produce between one mutation in 1300 gametes and one mutation in 70 gametes. This is not a very wide range, considering how little we know about so many of the factors concerned. The narrowness of the range is the result of the action of two limiting features. The fact that the spontaneous mutation rate is known to be low despite the presence of a certain amount of irradiation in the atmosphere provides a maximum limit to the effectiveness of irradiation in producing mutations. The comparison of the progeny of control and irradiated animals provides the lower limit for the relative effectiveness of irradiation. The range thus being set, the points on the scale at which this range might be placed are limited by our knowledge that the average man is carrying some, but not many, deleterious recessive genes. Within these limits it is difficult to suggest that one part of the scale is better than another. The lower limits of the effectiveness of irradiation seem most likely because attempts to find radiation-induced mutants, and particularly the experiments of Hertwig, who tested for any sort of mutant within the entire genome, have been hearteningly meager in their successes.

Some of the values that have been imprecisely estimated here can be refined in the near future. Of particular importance is an extensive study of both the fertility and viability of the descendants of irradiated mammals. This will help us to determine whether or not many genes will be produced that decrease viability without being detectable as lethals. Studies of the children of related individuals will make up the other main source of information, because this will be one of our most fruitful ways to determine the actual value for man's current genetic structure. The comparison of spontaneous mutation in man with that in other mammals will also be of value.

What would happen to man if the mutation rate were permanently doubled by an accidental poisoning of the atmosphere by irradiation? It would be several generations before the accumulation of new mutations would amount to very much. The average number of deleterious mutations would increase, and the frequency with which persons bearing the same mutants would marry and have defective offspring would increase too. For completely recessive genes, the doubling of the mutation rate means that the frequency of the gene and of abnormal homozygotes in the population is increased as the square root of the mutation rate. A gene that had had a frequency of 0.00010 would eventually build up to a frequency of 0.00014. With such small changes, it would seem unlikely that a doubling of the mutation rate could pose a serious problem to the life of the species, and it might go almost unnoticed. Some of our current dysgenic practices that are countenanced because of custom, inertia, humanitarian practices, or foolishness are probably more serious to the species.

Lest anyone misinterpret these deliberations as

justification for rashness, some special warning should be given. The basic fact to remember at all times is that any irradiation is bad, and therefore irradiation should be used only if it can be assumed that the good will outweigh the bad. Certainly our descendants should be protected by our avoiding the irradiation of the gonads of any person until he is past the procreative age. Also, the society as a whole should be protected against a general increase in background irradiation. The existence of worse practices cannot be an excuse for perpetrating a bad one.

References and Notes

* Present address: Argonne National Laboratory, Box 299, Lemont, Ill.

1. R. D. Evans, *Science* **109**, 299 (1949).
2. S. Wright, *J. Cellular Comp. Physiol.* **35** Suppl. 1, 187 (1950).
3. H. J. Muller, in *Radiation Biology*, A. Hollaender, Ed. (McGraw-Hill, New York, 1954), vol. 1.
4. H. M. Slatis, *Am. J. Human Genet.* **6**, 412 (1954).
5. J. V. Neel and W. J. Schull, *Human Heredity* (Univ. of Chicago Press, Chicago, 1954).
6. J. B. S. Haldane, *Proc. 8th Intern. Congr. Genet.* (1949), p. 267.
7. A. C. Allison, *Brit. Med. J.* **1954I**, 290 (1954).
8. H. M. Slatis, *Am. J. Human Genet.*, **7**, 76 (1955); H. Nachtsheim, *Eugenics Quart.* **2**, 9 (1955).
9. C. Stern *et al.*, *Genetics* **37**, 413 (1952).
10. H. J. Muller, *Am. J. Human Genet.* **2**, 111 (1950).
11. S. G. Levit, *J. Genet.* **33**, 411 (1936).
12. W. L. Russell, in *Radiation Biology*, A. Hollaender, Ed. (McGraw-Hill, New York, 1954), vol. 1, p. 825.
13. Compare with the isoalleles found by H. M. Slatis, *Genetics* **40**, 5 (1955).

News and Notes

Science News

The United Nations Educational, Scientific and Cultural Organization is sponsoring the establishment of an **International Computation Center** in Rome. The convention setting up the center will come into force when 10 states have ratified or formally accepted it. So far four countries—Belgium, Ceylon, Italy, and Japan—have deposited ratifications or instruments of unconditional acceptance. The convention has been signed by eight states: Egypt, Greece, Iraq, Israel, Liberia, Mexico, the Netherlands, and Turkey.

The projected center, a laboratory equipped with the best available mechanical devices for calculation, will have three main functions: scientific research, training of experts through a system of fellowships, and the provision of services to organizations and persons who, under certain conditions, will be authorized to request calculations required to solve unusually complex scientific, technical, administrative, or financial problems.

In cooperation with the Royal Australian Air Force, the U.S. Air Force is to operate an inland **meteorological research station** near Alice Springs, Australia. This station will supply information to scientists at the Woomera rocket range in South Australia, and at the new weapons-testing site at Maralinga, Australia, 50 mi north of the transcontinental railway, midway between Kingoonya and Leakin. Atomic clouds that form above the Maralinga range are expected to drift in the direction of the new station in central Australia.

Two species of imported parasitic flies may aid in **sugarcane borer control,** the U.S. Department of Agriculture reports. After 2 years of tests, research entomologists at the USDA Sugarcane Field Station, Houma, La., describe the parasites as "promising" for gaining partial control of the destructive sugarcane insect, and some Louisiana cane growers have imported and released the flies in their fields.

One of the flies—*Metagonistylum minense*—came originally from the Amazon; the other—*Lixophaga diatraeae*—from Cuba. Both attack the borer in the same way. They deposit their eggs near the entrances of holes made by the borers in the sugarcane stalks. The eggs hatch almost immediately into maggots that move into the holes and destroy the borers.

In cooperative research with the Louisiana Agricultural Experiment Station, USDA's Agricultural Research Service has successfully imported these flies from Trinidad and established them on at least four Louisiana sugarcane plantations. A year after their release on one plantation, the parasitic flies achieved 75 percent borer control. New generations of the flies had migrated as far as 2 mi from the original release point.

Investigators speak in terms of "partial" control, because they anticipate that, as with other parasitic insects, populations of these flies will tend to ebb and flow as they are influenced by host abundance and prevailing weather. However, even some help would be welcome to growers, who must pay about $9 an acre annually to have their cane dusted with insecticides for borer control. Dusting is justified if 7 shoots of cane in 100 ft of row are infested. If parasites could reduce the infestation to below 6 infested shoots per 100 ft of row, at least one and perhaps two of the seasonal dustings could be eliminated.

General Motors Research Laboratories Division and the Medical College of South Carolina have announced development of the **electrostethograph,** a device that makes it possible to study heart sounds that are inaudible through a stethoscope. The new machine utilizes both an oscilloscope and a direct-writing mechanism. The patient lies on a foam rubber mattress that absorbs any interference vibrations, and the recording is made through a small flat disc that is placed on the chest.

Yale University has announced the acquisition of the ***Codex Paneth,*** a 1378-page volume that is believed to have been the entire medical library of the University of Prague when it was founded in 1347. The work comprises 42 separate texts that represent

a cross section of all medical knowledge available at the beginning of the 14th century. For more than 70 years, the *Codex* has been owned by the Paneth family of Germany, its most recent owner having been director Friedrich A. Paneth of the Max Planck Institute, Heidelberg. The volume was presented to the Yale medical library by 60 of the library's associates.

Albert M. Day, assistant to the director of the U.S. Fish and Wildlife Service who retires this month, will head a study of **North American waterfowl** for the Arctic Institute of North America. Work on preliminary aspects of the investigation, to be sponsored by the institute with the support of private contributors, will commence 16 June at the institute's Washington, D.C., office.

The purpose of the project is to study the programs and policies of all land and water-use agencies that directly or indirectly affect the breeding, protection, and perpetuation of waterfowl on the continent.

While the sportsman's "take" of wild ducks and geese is carefully controlled under treaties among the United States, Canada, and Mexico, increasing pressures upon waterfowl habitat resulting from the elimination of marshlands continue to cause concern among conservationists. The Arctic Institute is interested in this problem because the birds are of basic economic value to some 150,000 Eskimos and Indians in the arctic and subarctic regions of Canada and Alaska. Before adequate measures can be formulated to meet waterfowls needs, a thorough evaluation of the present situation is indicated.

Reports from the waterfowl research project are expected to cover such subjects as the effect on waterfowl of progressive drainage of swamps, marshlands, and prairie potholes for agricultural and commercial purposes; of large water impoundments such as TVA; and of the increasing encroachments of civilization in the far North, particularly during the summer months when the birds are nesting. The location and extent of present waterfowl refuges will be studied, and consideration given to the relationship between the loss of waterfowl habitat and the alarming reduction of ground water levels in certain areas.

The complete **plans of the first nuclear reactor** can be purchased from the U.S. Commissioner of Patents for 25 ct. The first patent ever issued for the device that made use of atomic energy possible was granted to the late Enrico Fermi, Nobel laureate, and Leo Szilard of the department of biophysics at the University of Chicago. Containing 27 sheets of drawings and 30 sheets of printed matter, the reactor patent is comparable to a textbook on atomic energy. The documents contain some details that have not been published heretofore. Among these are (i) an explanation of "danger coefficients," those factors that might be dangerous or that might inhibit the continuation of a chain reaction; (ii) an explanation of "exponential pile," that is, the geometry of the nuclear pile that must be constructed so that the neutron density declines exponentially with distance from the source; (iii) two methods for calculating pile design; (iv) three reactor designs—one with a solid moderator, one with a liquid moderator, and one with a beryllium moderator.

In their 10½-year-old application, Fermi and Szilard stated:

> We have discovered certain essential principles required for the successful construction and operation of self-sustaining neutron chain reacting systems (known as neutronic reactors) with the production of power in the form of heat.

In concluding their description, the men said: "With modifications, the reactors herein described can also be used as sources of power in useful form."

Successful **long-distance radio transmission** at frequencies in the 30- to 40-Mcy/sec band was announced at the convention of the Institute of Radio Engineers in New York. High power, about 30 kw, is required to transmit the signals. U.S. armed forces have been using the new system since January 1954 for communication between Goose Bay, Labrador, and Thule, Greenland, by way of Sondrestrom, south central Greenland.

The new high-power system of radio propagation at very high frequencies is subject to less atmospheric interference than conventional short-wave systems, which operate at frequencies in the 3- to 30-Mcy/sec band. The 30- to 40-Mcy/sec band is now used for low-power, short-range transmission—Army field telephones, police broadcasts, and industrial communication. Most of the radio-frequency power in the new method is lost, but some is reflected in the lower part of the E layer of the ionosphere. This portion is received by high-gain directional antennas.

The scientists who first reported experimental discovery of the new type of radio propagation were D. K. Bailey, R. Bateman, and G. F. Montgomery of the National Bureau of Standards; L. V. Berkner of Associated Universities, Upton, N.Y.; H. G. Booker of Cornell University; E. M. Purcell of Harvard University; W. W. Salisbury of Collins Radio Co., Cedar Rapids, Iowa; and J. B. Wiesner of Massachusetts Institute of Technology.

This year Ruth Patrick, curator of limnology in the Academy of Natural Sciences of Philadelphia, will lead an **expedition to the Amazon River in South America** for the purpose of studying the biological pattern of the stream. For 8 years she and her staff of biologists have been studying North American rivers. To advance knowledge of what constitutes a healthy stream, it is necessary to examine a tropical river for comparisons. The expedition is sponsored by the Catherwood Foundation, of which Cummins Catherwood, of Bryn Mawr, Pa., is president. This foundation has been supporting the academy's research extensively, one important phase being development of the Catherwood diatometer, an instrument originated by the academy. It is used in the collection of diatoms, which provide an index to the biological condition of a stream.

An advance party left by air 30 May for Lima, Peru; it consisted of Patrick, Matthew Hohn, assistant curator, and H. Radclyffe Roberts, director of the academy. From Lima they will fly over the Andes and into the Amazon basin of Brazil for the purpose of locating stations for the scientific collecting and field laboratory work that will be done in the fall by an academy team that will consist of biologists, chemists, and bacteriologists.

Three men have **left for Japan** to discuss the peacetime uses of atomic energy with Japanese businessmen, industrialists, and scientists. The mission consists of John Jay Hopkins, chairman of the board and president of the General Dynamics Corp., which built the first two atomic-powered submarines; Ernest O. Lawrence, University of California Nobel laureate in physics; and Lawrence R. Hafstad, former director of the division of reactor development for the Atomic Energy Commission and now director of the atomic energy division of the Chase National Bank in New York. The invitation to visit Japan, which was endorsed by Japanese Government officials, was extended earlier this year by Matsuraro Shoriki, Toyko newspaper publisher and businessman.

Scientists in the News

Chie Nakane, a Japanese woman anthropologist, and **Asta Ekenvall** of Sweden have been chosen from 77 applicants representing 13 countries as the first recipients of the Swedish Elin Wägner scholarship for research on "Woman's role in history." They will receive Kr. 5000 each. Nakane will study the remains of a matriarchal society in Assam and Malabar, and Ekenvall will investigate women's intellectual creative contributions to Western culture.

The Willard Gibbs medal, one of the highest awards in chemistry, was presented on 20 May to **Farrington Daniels,** University of Wisconsin chemistry professor, at the annual dinner of the Chicago section of the American Chemical Society. The medal is awarded annually by the society to a chemist whose achievements have been particularly outstanding. In the years since it was established—1910—the medal has been given to eight men who became Nobel prize winners.

James A. Halsted has been appointed chief of professional services at the Veterans Administration Hospital, Syracuse, N.Y., and associate professor of medicine at the State University of New York College of Medicine at Syracuse. He was formerly a member of the staff at the Veterans Administration Hospital in Los Angeles and on the faculty of the University of California Medical Center.

Franklin V. Taylor, head of the engineering psychology branch at the Naval Research Laboratory and acting head of the engineering psychology branch at the Office of Naval Research, will leave in mid-June for Cambridge, England, where he will work under Frederick Bartlett of the Applied Psychology Unit, Medical Research Council of Great Britain. As an additional duty, Taylor will survey the progress of engineering psychology in Europe for ONR.

P. Piganiol, director of research, St. Gobain, Chauny and Cirey, France, spoke on 2 June at the Polytechnic Institute of Brooklyn on "Progress in polymer research in France."

Lady Dhanvanthi Rama Rau of India received the Albert and Mary Lasker award from the Planned Parenthood Federation of America at its 35th annual luncheon in New York on 6 May. The citation said:

> As Chairman of the International Planned Parenthood Federation, she has combined the pioneer child spacing experience of America and Europe with the profound needs and insights of the Orient to give a new vitality to the entire movement. . . . She has displayed a genius for breaking the right tradition at the right moment. . . .

Alfred H. Stanton, assistant professor of psychiatry at Boston University School of Medicine, has been appointed psychiatrist-in-chief of the McLean Hospital, Waverley, Mass., and associate professor of psychiatry, Harvard Medical School. Stanton, an authority on social psychiatry, at present is also chief of the psychiatric closed ward section of the Boston Veterans Administration Hospital. He will take over his new duties in the near future at the McLean Hospital, which is a division of the Massachusetts General Hospital, a teaching hospital associated with the Harvard Medical School.

Charles L. Critchfield, professor of physics at the University of Minnesota, has been appointed director of scientific research for the Convair Division of General Dynamics Corp. He was one of 14 scientists recently announced as consultants for Convair. A mathematical physicist, much of his work has been in the theories of nuclear reactions, transmutations in stars, and nuclear forces and in the electron-positron pair theory of nuclear forces.

Richard W. Tiecke, former deputy chief of the oral pathology branch of the Armed Forces Institute of Pathology, Washington, D.C., has been appointed associate professor in the department of pathology at Northwestern University. In addition to conducting research in oral cancer and teaching at the dental school, he will serve on the consulting staffs of several Chicago hospitals that are affiliated with the university.

Robert F. Thomson, head of the metallurgy department of the research laboratories division of the General Motors Corp., has received the John A. Penton gold medal from the American Foundrymen's Society. The award, one of the society's highest honors, was presented for "outstanding contributions to the society and the industry in foundry research, particularly in the field of light metals."

Herbert Riehl of the department of meteorology, University of Chicago, will join the staff of the University of Colorado's High Altitude Observatory at Boulder, 27 June–15 Aug. The appointment was made possible by the Munitalp Foundation, whose director of research, Vincent J. Schaefer, is well known for his interest and research in matters related to jet-stream phenomena. Riehl's work at Boulder will be closely related to the scientific program of the foundation. He will conduct a special seminar on problems of solar-weather relationships, jet-stream formation, and other problems of the general circulation of the earth's atmosphere, and he will carry out research in solar-weather relationships.

Albert G. Hogan, professor of animal nutrition and chairman of the department of agricultural chemistry, University of Missouri, was honored by friends, colleagues, and former students at a dinner held in Columbia on 21 May. Hogan will retire this year after 35 years of service at the University of Missouri. At the dinner his former students presented the university with a portrait, and the Hales and Hunter Co. of Chicago announced the establishment of a graduate fellowship in his name.

Harry N. Holmes, emeritus professor of chemistry at Oberlin College and former president of the American Chemical Society, has received the James Flack Norris award of the society's Northeastern Section. The award, which consists of a medal, a scroll, and approximately $1000, is conferred biennially to recognize "outstanding achievement in the teaching of chemistry."

James D. Hardy, associate professor of surgery at the University of Tennessee College of Medicine, will become professor and head of the department of surgery at the University of Mississippi on 1 June. Mississippi will open a new 4-year medical school in September.

T. H. Goodding, professor of agronomy, has received the University of Nebraska Foundation Award for Distinguished Teaching in the physical and technologic sciences. This award, which consists of a medal and $1000, was presented to Goodding at the 27th Annual Honors Convocation. Goodding joined the university's staff in 1917 as an agricultural extension specialist.

Two appointments have been announced by the American Cancer Society. **Harry M. Weaver,** former research director of the National Foundation for Infantile Paralysis and until recently a research consultant for A.C.S., has been named the society's administrator for research; and **Frederick W. Nordsiek** has been made executive officer of the research department.

The first in a series of annual lectures in memory of **Rollin Turner Woodyatt,** internationally known Chicago physician, medical teacher, and investigator, was given on 20 May under the auspices of Northwestern University Medical School. **Evarts A. Graham,** emeritus professor of surgery at Washington University, St. Louis, Mo., and a close friend of Woodyatt, delivered the initial memorial lectures. Woodyatt, who died in 1953, devoted his professional life to the study of diabetes and was well known for his achievements in the care of diabetic patients.

Mary F. Blade, first and only woman teacher of engineering at Cooper Union, has been named director of Cooper Union's 1000-acre Green Engineering Camp at Ringwood, N.J. Blade has also been promoted to associate professor of mechanical engineering. Her appointment at Ringwood is effective on 1 Sept., when she will succeed **J. Merriam Peterson,** director of the camp since 1943. He has requested to be relieved in order to be able to devote more time to his work in chemical engineering.

Meetings

The 1955 annual meeting of the **Association for Computing Machinery** will take place in Philadelphia at the University of Pennsylvania 14–16 Sept. It is open to nonmembers of the association. The primary effort of the convention will be directed toward bringing the scientist and businessman together to discuss on an equal basis their particular progress and problems in connection with automatic computing and data-handling machines.

To this end, a series of papers reflecting the latest thinking in linear programming, logical and machine design, numerical analysis, and business applications and management techniques will be presented.

As an added opportunity for personal contact and the informal exchange of ideas, the association has planned a series of luncheons and discussion groups featuring well-known speakers. The subjects discussed will concern: computers in scientific applications; computers in industrial control and automation; computer application for accounting and management; the future of computers.

The association will consider papers for approval up to 15 June. Three copies of abstracts of not more than 120 words should be sent to the chairman of the program committee, Professor J. P. Nash, Digital Computer Laboratory, University of Illinois. Each paper will be limited to 20 minutes. The chairman of the local arrangements committee is Morris Rubinoff, Moore School, University of Pennsylvania.

It has been announced that the **Montreal Corrosion Symposium** will be held 15–16 Sept. at the Sheraton-Mount Royal Hotel in Montreal. This symposium is jointly sponsored by the National Research Council's Associate Committee on Corrosion, the Montreal Section of the National Association of Corrosion Engineers, and the Protective Coatings Division of the Chemical Institute of Canada.

The preliminary list of papers indicates that there will be participants from Halifax to Vancouver as well as from the United States. Among the subjects

to be discussed are corrosion of copper and gold alloys by ammonia solutions; fundamental testing of marine paints, and a review of present marine corrosion problems; fundamentals of pulp digester corrosion; fretting corrosion; corrosion aspects of plant design; cathodic protection; surface preparation of metals; and practical aspects of corrosion in the railway industry.

An **International Symposium on Macromolecules**, sponsored by the Commission on Macromolecules of the International Union of Pure and Applied Chemistry, will be held in Israel, 3–9 Apr. 1956. Host to this symposium will be the Weizmann Institute of Science, Rehovoth. Papers will be presented in three sections, to be held successively, on (i) general behavior of polymers in solution; (ii) behavior of biocolloids and polyelectrolytes in aqueous solutions; and (iii) the behavior of special polymeric systems. For further information write to Prof. A. Katchalsky, Weizmann Institute of Science, Rehovoth, Israel.

Education

In mid-May ground was broken for construction of a $1-million medical clinic building at **Emory University**. R. Hugh Wood, dean of the medical school, is clinic director. The five-story stucco and limestone structure will face Emory University Hospital and is expected to be completed within the year. Nearby are the recently constructed Woodruff Memorial Research Building, and Aidmore Hospital. Also affiliated with Emory's medical activities are the Glenn Building at Grady Hospital, downtown headquarters of the medical school; the new Grady Hospital that is under construction and which will be staffed by Emory; and a proposed Communicable Disease Center, a six-building project that will go up on a 15-acre tract near the university hospital.

A course in **scientific writing** for teachers of science, teachers of English, and administrators is being offered by the University of Virginia, 5 July–13 Aug. The course will be divided into four major areas of interest: library resources; research techniques and experiments applicable to the high school level; the scientist's problems in writing and speaking; and the practical application of information and technique to teachers' individual problems, such as organizing material for science fairs, writing copy for community exhibits, and advising students on specific projects. Teachers' participation with practicing scientists at top levels is expected to be one of the rewarding features of the course.

A series of **laboratory refresher training courses** will be given at the U.S. Public Health Service Communicable Disease Center during the period July 1955–June 1956. Information and application forms should be requested from the Laboratory Training Services, Communicable Disease Center, P.O. Box 185, Chamblee, Ga.

Physicians from underdeveloped countries who are sponsored by the World Health Organization may now be **trained in the Federal Republic of Germany.** Special schools have been arranged for that purpose at Düsseldorf, Hamburg, Mainz, and Munich. Previously, doctors from these countries have gone to Great Britain and the United States. The expenses involved are paid by WHO.

Miscellaneous

The Wistar Institute of Philadelphia, Pa., plans to discontinue by 1 July the breeding of seven mutant strains of rats (chocolate, chocolate shaggy, yellow black eye, yellow red eye, curly, white shaggy, and mutant albino) developed by the late Helen D. King. These **rats are offered free** to any scientist or institution willing to maintain them for breeding purposes. The numbers of rats available is limited. For information write to Dr. Edmond J. Farris, Wistar Institute of Anatomy and Biology, 36th and Woodland Ave., Philadelphia 4, Pa.

Scenes from Atomic Energy Commission plants in Idaho and Pittsburgh, now unclassified, will be seen publicly for the first time in a new 30-min movie produced and soon to be released by the Westinghouse Electric Corp. Entitled "A Dawn's Early Light" and filmed in both color and black and white, the picture stars Fred MacMurray and features Fay Wray and Jack Dimond. The reel was made with the technical assistance of the U.S. Atomic Energy Commission and the Department of Defense. The film presents stages in the construction of the nuclear power plant for the U.S.S. *Nautilus*. One portion shows the shipment of the reactor core from the AEC's Bettis plant near Pittsburgh to Idaho, where it was installed in a full-scale, land-based model of the *Nautilus* power plant.

"A Dawn's Early Light" is suitable for social, service, and school groups, civic organizations, and professional groups. It is available on loan without charge and can be purchased outright. For information write to the Film Division, Westinghouse Electric Corp., P.O. Box 2278, Pittsburgh 30, Pa.

The **New York Diabetes Association, Inc.,** has moved its offices from 2 E. 103 St. to 270 Park Ave., New York 17.

The **Chemical-Biological Coordination Center** of the National Academy of Sciences–National Research Council has prepared a pamphlet that is designed to help research personnel formulate questions for submission to the center. The pamphlet, which was prepared under the direction of G. Congdon Wood, head of the biology group, lists examples of nearly every type of question that the center has ever received. Entitled *Types of Questions Answered by CBCC*, the publication contains approximately 12 percent of all questions received between December 1952 and March 1955.

Book Reviews

Millimicrosecond Pulse Techniques. I. A. D. Lewis and F. H. Wells. McGraw-Hill, New York; Pergamon Press, London, 1954. iv + 310 pp. Illus. + plate. $7.50.

The field of very short pulses is a quite difficult one, and the experimenter is hampered by having no equipment to view the pulses whose indication can be completely believed. For this reason, any help he can get is greatly appreciated. This book provides a considerable amount of good advice and many references to more.

The first chapter contains a quick review of circuit analysis and the application of the Fourier and Laplace transforms to the problems of transient analysis. The second and third chapters are devoted to an exposition of the use of transmission lines both for the transfer of short video pulses and as circuit elements for forming or modifying pulses. The discussion also includes the use of coupled lines for pulse inversion. Chapters 4–6 describe the design of pulse generators, amplifiers, pulse discriminators, and cathode-ray oscilloscopes for millimicrosecond pulses. The last two chapters discuss application of short-pulse equipment to numerous problems in nuclear physics and other fields of physical measurement.

The treatment of transmission-line problems is very good and quite detailed. The effects of changes of dimension without change of impedance, support beads, and terminations upon pulse shape are considered. Chapter 3 is concerned mostly with the use of tapered transmission lines, either plain or helical, as pulse transformers for increasing or decreasing pulse size, for impedance matching, or for pulse inversion with or without a change of pulse size.

The next chapter, dealing with signal generators, describes most of those in general use for testing equipment using millimicrosecond pulses. It includes the contact type (of which the mercury-switch pulser is a familiar example) as well as the gas tube and secondary emission-tube types. This section, and indeed the whole book, has a quite extensive bibliography that gives a useful starting point for those who do not follow the literature on this subject.

The chapter on amplifiers includes the circuit considerations and some details of the design of 100- and 400-megacycle wide amplifiers for oscilloscope use. The limitations of cathode-ray tubes when they display pulses with swift rise and fall are considered at length in Chapter 6, and the performance of some tubes is illustrated. Time base circuits giving sweeps as short as 4 millimicroseconds are shown.

The last two chapters on applications should be useful to many experimenters. Many coincidence arrangements are shown, including the exceedingly useful and widely used fast-slow coincidence circuits that are required for coincidence with energy selection. The only thing lacking is a good discussion of the statistical problems that enter into the choice of the type of coincidence circuit and the time constants of the various sections of the circuits. A short discussion of time interval analysis and multichannel time analyzers is included in this section.

In general, this book provides a survey of millimicrosecond methods and an excellent bibliography for further reading, although the section on transmission lines is exceptionally detailed and by far the best I have seen.

P. R. Bell

Physics Division, Oak Ridge National Laboratory

Endemic Goiter. The adaptation of man to iodine deficiency. John B. Stanbury, Gordon Brownell, Douglas J. Riggs, Hector Perinetti, Juan Irdiz, and Enrique B. Del Castillo. Harvard Univ. Press, Cambridge, 1954. xii + 209 pp. Illus. $4.

This treatise on endemic goiter is based on observations made with modern tools of study by a group of investigators from the Massachusetts General Hospital and the Harvard Medical School, in collaboration with several endocrinologists from Argentina. The study was made on a large group of goiterous people in Mendoza, an Argentine province situated on the western slope of the Andes.

The monograph is divided into three sections. The Mendoza endemic goiter and the methods of study are first described, then the functional interrelationships observed in these goiterous people, and, in the last section, the authors present certain theoretical aspects of iodine metabolism with practical mathematical formulas that are applied in evaluating and interpreting the studies.

The studies that were made on these goiterous subjects included the determination of serum hormonal iodine, urinary iodine, and the thyroid's avidity for and the fate of radioactive iodine. The effects of iodine in small and large doses, desiccated thyroid, and methimazole were defined, and the effects of the thyroid-stimulating hormone on these indices of thyroid function were also defined. The results indicate that man is able to adapt himself in a remarkable fashion to an iodine-deficient state and maintain himself in a state of euthyroidism.

This monograph will probably not be of practical value to the practising physician. However, it should be of great value to experimental endocrinologists and biophysicists. Those engaged in studies of thyroid physiology and of iodine metabolism will find the theoretical aspects of iodine metabolism and the mathematical formulas most valuable.

Rulon W. Rawson

Memorial Center for Cancer and Allied Diseases, New York, N.Y.

Transactions of the International Astronomical Union. vol. VIII. Eighth General Assembly, 4–13 Sept. 1952, Rome. P. Th. Oosterhoff, Ed. Cambridge Univ. Press, New York 22, 1954. ix + 887 pp. Illus. $10.50.

This volume contains the reports of the 38 commissions of the International Astronomical Union that were made at the eighth general assembly, held at Rome in 1952. Important additions included in this volume of the transactions are the papers given at four symposia. These provide excellent current surveys of stellar evolution, astronomical instrumentation, problems of astrometry of faint stars, and spectra of variable stars. The book concludes with a list of the more than 800 members of the International Astronomical Union.

It is manifestly impossible in a short review even to outline the scope of a volume of nearly 900 pages that compiles the astronomical research completed or in progress through 1951. It is certainly one of the most important volumes of astronomical research in print, with the subjects treated ranging all the way from the history of astronomy to radio telescopes. This single volume will be an indispensable guide and reference for astronomical research in all fields and in all parts of the world.

CARL K. SEYFERT
Arthur J. Dyer Observatory, Vanderbilt University

Physical Methods of Organic Chemistry. vol. I, pt. III of ***Technique of Organic Chemistry.*** Arnold Weissberger, Ed. Interscience, New York–London, rev. ed. 2, 1954. xi + 433 pp. Illus. + plate. $8.50.

This series has become a standard reference work for the graduate student and investigator. Instead of rewriting volume I, parts I and II, this third part is published as a new volume in order to bring the other two parts up to date and also to include the more recent techniques in the physical methods of organic chemistry by adding new chapters. This was a wise decision in that it is psychologically easier to add a volume to one's library than it is to throw one away and replace it by a new edition.

Part III treats the following new topics as chapters: "Electron microscopy" (F. A. Hamm), "Microspectroscopy" (E. R. Blout), "Determination of streaming birefringence" (R. Singer), "Measurement of dielectric constant and loss" (J. G. Powles and C. P. Smyth), "Radio-frequency spectroscopy" (B. P. Dailey), and "Neutron diffraction" (J. M. Hastings and L. M. Corliss).

Each topic is discussed in detail from the standpoints of definition and limitations of the method and of special techniques for application of the method. The theoretical and mathematical backgrounds are not too difficult to be grasped by most organic chemists. Physical chemists will have no difficulty in these respects. In most chapters examples are included that seem to have been selected with a desire to elucidate the scope of the procedures described. Some examples also illustrate the limitations that are encountered in using the methods.

The following supplementary chapters to parts I and II are included: "Viscometry of dilute polymer solutions" (T. E. McGoury and H. Mark), "Determination of crystal structure of organic compounds by x-ray diffraction" (D. Harker), "Electron diffraction by the sector-microphotometer method" (L. O. Brockway), "Determination of magnetic susceptibility" (P. W. Selwood), and "Determination of radioactivity by scintillation counting" (J. F. Bonner).

These supplementary chapters discuss theoretical developments and some experimental examples that have appeared since publication of the earlier parts. Descriptions of actual techniques are limited in this section, and the investigator should refer to parts I and II for these details.

Two points stand out in this book. First, the explanations are very clear, and anyone who is not familiar with all the newer physical techniques as applied to organic chemistry (and who is!) will find very little difficulty in following the development of the various topics. Second, the mathematical background has been limited to the necessary material required to understand why and how the methods operate.

An encouraging feature of this series is the fact that the authors of the various chapters are listed on the title page; failure to do this has been deplorable in some other collaborative work. However, listing them as "contributors" should be changed to "authors," since this has a more exact semantic content.

The general make up of the book is excellent, and the index is adequate without being unnecessarily long.

THOMAS S. GARDNER
Hoffmann-La Roche Inc.

Decision Processes. R. M. Thrall, C. H. Coombs, and R. L. Davis, Eds. Wiley, New York; Chapman & Hall, London, 1954. viii + 332 pp. Illus. $5.

This volume contains a collection of 19 papers either presented at or an outgrowth of an 8-week seminar series on "The design of experiments in decision processes" held in 1952 at Santa Monica. Indirectly, it stems from a series of seminars on the role of mathematics in the social sciences that were started in the fall of 1950 at the University of Michigan.

> The title *Decision Processes* does not imply that the papers are limited to the branch of statistics bearing that name. The individual papers range in character from pure mathematics to experiments in group dynamics, but all are directed at the application of mathematics to behavioral sciences in general and at decision processes in particular. [p. vi]

The introductory paper by R. L. Davis serves to lend a degree of unity to the collection. Of particular interest is the second paper by Coombs, Raiffa, and

Thrall on "Mathematical models and measurement theory," which reviews the role of mathematical models in a science and their application in measurement theory.

The volume is divided into four parts. The first part deals with both the standard problem of statistical decision and the problem of group choice. Milnor, in "Games against nature," discusses the properties of four decision-making criteria. Coombs, in "Social choice and strength of preference," shows how to derive, under certain conditions, a social utility function that explicitly weights individuals' strength of preference. Part 2 deals with learning theory, with contributions by Bush, Mosteller, Thompson, Estes, and Flood.

Part 3 deals with the problem of utility that has been a central one in economic theory for many years. In this section, Marschak, in "Towards an economic theory of organization and information," extends ". . . the economic theory of a rational firm into the domain of uncertainty, giving special regard to the character of a firm as a team." How shall a team, a group for which the group interest coincides with the individual's interest, act to maximize its gain? Part 4 describes some experimental studies. Thus, for example, Hoffman, Festinger, and Lawrence, in "Tendencies toward group comparability in competitive bargaining," examine experimentally the game-theory assumption that players decide on coalitions strictly on the basis of their desire to maximize their returns. They examine the behavior of players in terms of more realistic utility systems that include a comparison of one's own performance ". . . with the performance of others whom they accept as comparable to themselves."

Decision Processes contains a stimulating series of articles, adding significantly to the growing body of literature on the role of mathematics in the social sciences. The papers that I have singled out for mention met only one criterion—their interest to me.

IRVING ROSHWALB

Opinion Research Corporation

Advances in Catalysis and Related Subjects. vol. VI. W. G. Frankenburg, V. I. Komarewsky, and E. K. Rideal, Eds. Academic Press, New York, 1954. xiii + 467 pp. Illus. $10.50.

A very puzzling problem in the behavior of contact catalysts is the increase in the frequency factor with decreasing activation energy when the simple Arrhenius equation is used for many reactions. Two possible explanations are presented in this book. In a stimulating chapter on the general aspects of chemisorption and catalysis, Takao Kwan shows that both the frequency factor and the activation energy vary with the fraction of the surface covered by adsorption, and he calculates the extent of the variation from an almost bare surface to one that is completely covered. P. B. Weisz and C. D. Prater, in their chapter on interpretation of measurements in experimental catalysis, discuss results of rate measurements on catalysts of the same chemical composition but of different physical form (for example, pore size distribution). They show that an apparent linear relationship between the logarithm of the frequency factor and the activation energy results from influences of different diffusion factors on the rate of reaction.

This volume also contains informative reviews of catalysis and reaction kinetics at liquid interfaces by J. T. Davies, synthetic polymer catalysts by W. P. Dunworth and F. F. Nord, commercial isomerization by B. L. Evering, acidic and basic catalysis by M. Kilpatrick, and industrial catalytic cracking by R. V. Shankland. This last-mentioned topic is the largest section of the book and is an excellent presentation of the current state of the art of catalytic cracking of petroleum.

H. H. STORCH

Stamford Research Laboratories, American Cyanamid Company

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to *Science*, but to the publisher or sponsoring agency.)

Anales. vol. III, No. 3. Ministerio de Agricultura. Instituto Nacional de Investigaciones Agronomicas, Madrid, 1954. 134 pp. Illus.

A Systematic Monograph of the Dermaptera of the World. Based on material in the British Museum (Natural History). Pt. 1, *Pygidicranidae*. W. D. Hincks. British Museum (Natural History), London, 1955. £1 15s. 132 pp.

Malaria: A World Problem. vol. 9, Nos. 2–3, of *Chronicle of the World Health Organisation*. World Health Organization, Geneva, 100 pp. 60¢.

Jaarboek der Koninklijke Nederlandse Akademie van Wetenschappen, 1953–1954. The Akademie. North-Holland, Amsterdam, 1954. 315 pp. Illus.

Carnegie Institution of Washington Year Book No. 53. The Institution, Washington, 1954. 311 pp. Illus. Paper, $1; cloth, $1.50.

Recent Sediments of the Gulf of Paria. Reports of the Orinoco Shelf Expedition. vol. I. Tj. Van Andel and H. Postma. North-Holland, Amsterdam, 1954. 240 pp.

Pericula Prope Amenanum Zuri Epistola ad Discipulum. Certaminis Poetici Hoeufftiani. Academia Regia Disciplinarum Nederlandica, Amsterdam, 1954. 18 pp.

Nuclear Science Abstracts. vol. 9, No. 6A. U.S. Atomic Energy Commission, Technical Information Service, Oak Ridge, Tenn., 1955. 48 pp.

Shopping Habits and Travel Patterns. Highway Res. Bd. Special Rpt. 11-B. Natl. Acad. Sciences–Natl. Research Council, Washington 25, 1955. 21 pp. 75¢.

Aphids and Scale Insects on Ornamentals. Bull. 588. John C. Schread. Connecticut Agr. Expt. Sta., New Haven, 1955. 22 pp.

Bulletin de l'Institut International de Statistique. Methodologie generale et statistique mathematique, statistique economique, enseignement de la statistique. Tome XXIV, 2ème livraison. L'Institut, Rome, 1954. 723 pp.

Heralds of Science. As represented by 200 epochal books and pamphlets selected from the Burndy Library. Burndy Library, Norwalk, Conn., 1955. 96 pp.

Technical Papers

Improved Hanging-Strip Paper-Electrophoresis Technique

F. G. Williams, Jr., E. G. Pickels, E. L. Durrum*

Specialized Instruments Corporation, Belmont, California, and Army Medical Service Graduate School, Washington, D. C.

The hanging-strip paper-electrophoresis technique for protein separation (*1*) is coming into wide use, particularly for clinical purposes (*2*). In this technique, the rack supporting the strip is removed from the cell at the end of an experiment and placed in an oven to dry and fix the protein pattern on the strips before they are dyed. It has been recognized for some time that distortions of the patterns occur during this drying stage. Attempts have been made to avoid this difficulty by placing the strips immediately in a dye-coagulant solution without the drying step (*3*). This expedient has the drawback that the proteins may not be thoroughly "denatured," which may lead to variations in dye uptake (*4*, Chap. 18). For separation involving substances that cannot be chemically coagulated or precipitated *in situ*, some drying procedure usually must be employed.

The degree of pattern distortion due to liquid redistribution incident to drying was conveniently visualized by the following procedure (Fig. 1, top). Reference circles were marked with a pencil on dry strips; the paper was saturated with buffer and then subjected to the electrophoresis procedure. Immediately prior to the drying step, spots of dye solution (acid fuchsin) were rapidly applied from a pen point at the reference marks. The strip was lifted from the buffer and was oven dried while it was still apically supported on the rack. The movement of the dye spots away from the reference marks then gave an indication of the magnitude of fluid redistribution and incidental pattern distortion. Similar experiments with serum proteins followed by dyeing showed distortions of like magnitude.

Pattern distortion can be substantially eliminated Fig. 1, bottom) if the following conditions, which are listed in their probable order of importance, are fulfilled. (i) Excess liquid at the dependent ends of the strips must be removed as soon as the vapor-saturated enclosure is opened. (ii) The application of heat to all areas of the paper strip should be uniform. (iii) The strip should not be dried in contact with any support within or near the region of the pattern. (iv) Drying should be carried out at a rapid rate to arrest fluid movement as quickly as possible.

When a rack is lifted from a cell, a drop of electrolyte is dependent from the ends of the strips (Fig. 2*B*). The drop of fluid acts as a reservoir continuously feeding electrolyte upward toward the apex of the strip in a manner analogous to ascending chromatography. This effect varies in magnitude along the length of the strip, being greatest near the ends and zero at the apex (Fig. 1, top). As a consequence, distortion of the protein pattern results with loss of resolution; and, further, observed mobilities are less than actual mobilities (*4*, Chap. 15).

An obvious solution to this difficulty would be to blot the ends of the strips prior to placing them in the oven. We tested a strip rack that carried a plastic support bar, against which the strip ends could be blotted after the rack was removed from the cell. It was found to be difficult to blot each strip end in a reproducible manner, and that downward displacement into excessively blotted ends sometimes occurred.

Another solution to this difficulty is to cut off the dependent ends of the strips prior to placing them in the oven. It has been found, however, that by employing a heavy filter-paper wick between the strip ends and the electrolyte reservoir, the desired effect is produced in a more convenient and reproducible manner (Fig. 2 *C*, *D*) as the strips are removed from the cell.

A support rod touching the strip during drying (*5*) produces a characteristic artifact presumably due to local shading and alteration of the drying rate owing to the heat capacity of the support. The strip should therefore not be dried in contact with any support in or near the pattern area.

The cell design illustrated in Fig. 2 *A* permits drying to be carried out without pattern distortion and preserves the advantages of the hanging-strip procedure, which utilizes gravity to promote the attainment of reproducible capillary equilibrium. The paper strips are removed at the end of the experiment on the detachable folding rack, which pulls them horizontal and almost taut, the pattern area of the strip hanging free from contact with the central support.

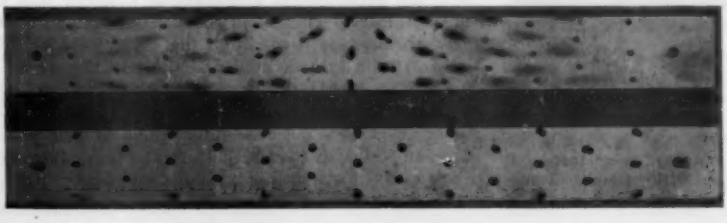


Fig. 1. Pattern distortion incidental to drying. (Top) Strip was dried over apical rod without removal of dependent drop (Fig. 2*C*). (Bottom) Strip was dried on the rack shown in Fig. 2 after removal from intermediate wick, without formation of dependent drop.

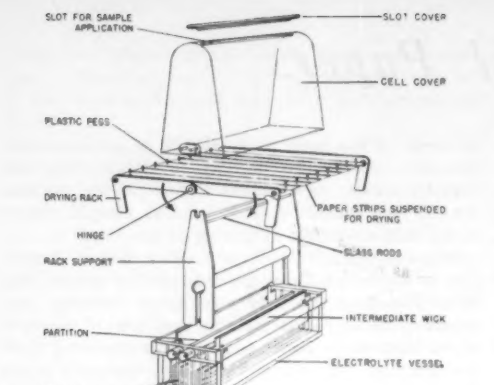


Fig. 2. Hanging-strip paper-electrophoresis cell and rack. (*A*) Cell with parts separated for visualization. (*B*) Formation of dependent drop of electrolyte. (*C*, *D*) Elimination of drop by intermediate wick.

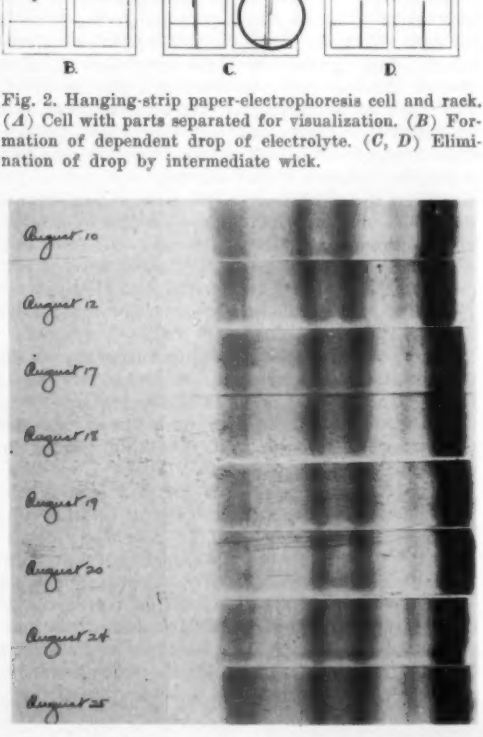


Fig. 3. Reproducibility study. Strips from eight different experiments, performed on the dates indicated, with the cell shown in Fig. 2. The experimental conditions were Whatman No. 3MM filter paper, eight strips 29 by 300 mm, 0.01 ml of serum applied at the apex, barbital buffer pH 8.6, $\mu = 0.075$, 16-hr duration, constant current of 8 ma (for eight strips), and stained with bromphenol blue (*4*, *6*).

Under these conditions the strips dry with practically no shift of the resolved zones. This procedure also prevents the formation of apical creases, which are difficult to avoid when any of the heavier papers (for example, Whatman No. 3MM) are dried over an apical rod. Since these creases are reproduced as spikes by most photoelectric scanners, they may obscure the "application artifact" which is caused by the presence of particulate material, traces of fibrinogen, and other substances in the serum that are precipitated or otherwise bound at the origin. The application artifact probably has clinical significance.

Figure 3 illustrates the reproducibility and resolution obtainable with apparatus of this design when Whatman No. 3MM strips, 29 by 300 mm were used. The same serum was studied during eight different experiments over the course of 2 wk.

References and Notes

* Present address: Department of Pharmacology, Stanford Medical School, San Francisco.

1. E. L. Durrum, *Abstracts of Papers, 115th Meeting, American Chemical Society* (1949), p. 22C; *U.S. Army Medical Dept. Field Research Lab. Rept.*, Proj. 6-24-12-06 (18) (1949); *J. Am. Chem. Soc.* **72**, 2943 (1950); *J. Colloid Sci.* **6**, 274 (1951).
2. F. V. Flynn and P. deMayo, *Lancet* **1951**, II, 235; M. Machebœuf, P. Rebeyrotte, M. Brunerie, *Bull. soc. chim. biol.* **33**, 1543 (1951); T. H. Spaet, *J. Lab. Clin. Med.* **41**, 161 (1953); Ch. Wunderly and B. Caglanut, *Ann. Oculist* **185**, 414 (1952).
3. H. G. Kunkel and A. Tiselius, *J. Gen. Physiol.* **35**, 89 (1951).
4. R. J. Block, E. L. Durrum, G. Zweig, *A Manual of Paper Chromatography and Paper Electrophoresis* (Academic Press, New York, 1955).
5. If support rods are small in diameter and are treated with a silicone antiwetting agent, no meniscus forms at the point of contact between the support rod and the paper during electrophoresis, and no distortion of field or other artifact is detectable.
6. W. P. Jencks, M. R. Jetton, E. L. Durrum, *Biochem. J.*, in press.

18 February 1955

Use of Narrow Holes for Producing Glow-to-Arc Transitions

Paul L. Copeland and B. Pearson De Lany

Illinois Institute of Technology, Chicago

When, in experimental apparatus designed to confine the cathode spot on the surface of a mercury pool to a small area (*1*), a pinhole is left in a funnel-shaped glass member joined to the envelope in a ring-seal (*2*), a glow-to-arc transition usually results in an arc passing through the pinhole. These observations are presented as unmistakable evidence that a concentration of current in the positive column of a glow discharge is a condition that favors the establishment of a cathode spot and the resulting transition to the arc. If the hole is in the millimeter-size range, the arc takes the path through it in the majority of cases over a considerable range of gas pressures. In a glow discharge, the current density through a hole of fixed size can be increased by adding appropriately placed conducting extensions to the cathode,

and this increases the probability that the arc will be set up through the hole.

The form of the tubes used in this investigation is suggested by Fig. 1. A hole is intentionally left in the wall of the constriction, and its approximate size is measured. With a given geometry, in which the size of the hole is a dominating factor, there is a definite variation with vapor pressure in the ratio of the number of times the arc is initiated within the constriction to the number of times it is formed through the hole in the constricting member. This is shown in Fig. 2, where the ambient temperatures of the experimental tube shown on the X-axis correspond to the vapor pressures shown at the top of the figure. The proportion of the glow-to-arc transitions that take the path through the hole is plotted on the Y-axis.

The sampling procedure is to raise the potential difference between anode and cathode until the arc is established and to record whether or not the arc column passes through the hole. The data plotted in Fig. 2 were obtained by repeating the procedure until 20 events of the same kind had been recorded, and since this did not result in samples of large size, considerable statistical fluctuation associated with the experimental points plotted is to be expected. The first curve, at the lower right-hand side of the figure, corresponds to a hole of approximately circular cross section with a diameter of about 1 mm. This curve shows the characteristic behavior of the phenomenon as the vapor pressure is varied. At low vapor pressure, none of the glow-to-arc transitions takes the path through the hole. The onset of the phenomenon requires sufficient vapor pressure to supply current carriers for the concentration of the current through the hole. At intermediate vapor pressures of about 1 mm, more of the glow-to-arc transitions take the path through the hole than take the direct path down the funnel. As the vapor pressure is raised above 1 mm, the proportion that take the path through the hole decreases. The cause of this decrease has not been

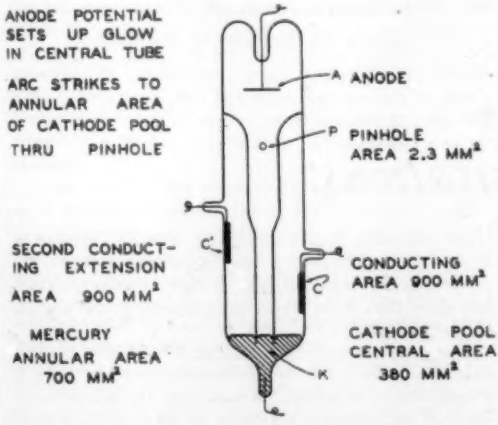

ANODE POTENTIAL SETS UP GLOW IN CENTRAL TUBE
ARC STRIKES TO ANNULAR AREA OF CATHODE POOL THRU PINHOLE
SECOND CONDUCTING EXTENSION AREA 900 MM²
MERCURY ANNULAR AREA 700 MM²
A ANODE
P PINHOLE AREA 2.3 MM²
CONDUCTING AREA 900 MM²
CATHODE POOL CENTRAL AREA 380 MM²
K

Fig. 1. Experimental tube for the production of glow-to-arc transitions through a pinhole.

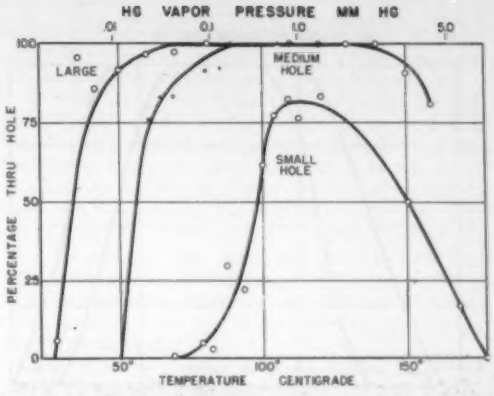


Fig. 2. Statistical distribution indicating the probability of the arc stream passing through holes of various sizes as a function of vapor pressure.

established. It should be mentioned, however, that at pressures in this range, the discharge begins to concentrate in streamers, whether or not there is a constriction anywhere along the path. Also, in this range of pressures, the potential gradient along the column increases; thus, the more direct path would be favored.

If the hole is enlarged, the transitions through the hole occur at lower pressures and also at somewhat higher pressures. The intermediate curve of Fig. 2 was obtained by using a hole of circular form having an approximate diameter of 2.5 mm. In this case only 0.1 mm of vapor pressure is required for the larger share of the transitions to take the path through the hole. There is a considerable range of vapor pressures in which transitions through the hole occur in virtually all the tests.

The curve marked "large" was obtained with a hole in the form of a slit about 1.5 mm wide and 6 mm long. Glow-to-arc transitions through this hole begin at pressures of slightly less than 0.01 mm. There is a relatively wide range of pressures in which glow-to-arc transitions take the path through the hole in virtually all the tests. There is a decrease in the proportion of transitions through the hole at the higher pressures, and further work with different experimental tubes has shown that this trend persists until the arc stream in all tests takes the direct path down the funnel.

The dependence of this phenomenon on pressure has been verified by experiments in which the gas used was air and also in other experiments in which helium was used. The data on tubes containing helium were especially interesting, for the breakdown potentials were very low and the glow-to-arc transitions were very rapid. The length of the arc stream in two such tubes was about 12 in., and the diameter of the hole was about 1.75 mm. At optimum pressure, estimated to be about 0.5 mm, glow in such tubes was set up at about 600-v potential difference, and the transition to the arc took place quickly. In another similar tube containing helium at a pressure of about

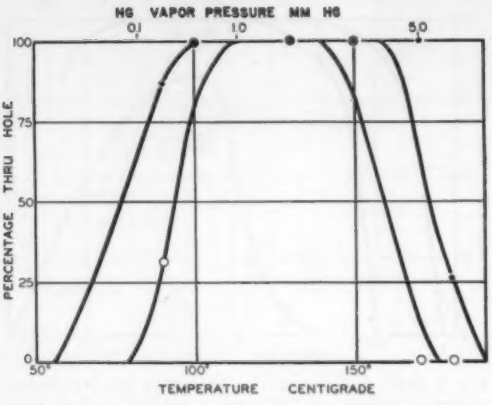


Fig. 3. Increase in the proportion of glow-to-arc transitions through a hole produced by the addition of a 900-mm² conducting extension to the cathode. Open circles indicate results obtained without the use of the extension. The small black circles indicate results obtained with one extension connected to the cathode through a 10,000-ohm resistance.

1.5 mm, the breakdown required 1000 v, but the transition was so rapid that the arc appeared to be set up directly.

Although the arc is often established so quickly that no glow appears to precede it, under other conditions the glow is seen to be established with the small portion of the pool within the funnel as a cathode. This area is so small that, with modest currents, an abnormal cathode fall is required for the liberation of the electrons from the cathode. In this case, there is a tendency for the glow to overspread a larger area of the cathode pool in order to reduce the abnormal cathode fall. Ions are present in the vicinity of the pinhole, and they are drawn through it by the potential gradient. A glow is then established in the large, outer portion of the tube. The pool area outside the constriction is sufficiently large that, with the potential difference applied, a relatively large concentration of the current is set up at the hole. Over a considerable range of vapor pressures, this provides the conditions needed to establish the arc along this path.

The efficiency of the process would be expected depend not only on the size of the hole but also on the cathode area outside the funnel. This has been verified by experiments performed with the tube shown in Fig. 1. As the drawing shows, this tube is provided with two conducting areas, C and C', that were made by painting the inside wall of the tube with a platinum alloy. Each of the two areas is provided with a lead-out wire by means of which it may be electrically connected to the cathode K. If this connection is made directly, the cathode spot is most likely to be set up on the platinum alloy, and the conditions in this case differ enough that comparisons with data in which the spot is established somewhere on the mercury pool may not be justified. To avoid such criticism, the platinum alloy areas have been connected to the cathode through a resistance of about 10,000 ohms. This resistance is high enough to prevent the formation of the cathode spot on the platinum alloy, but it is low enough to permit the alloy to serve as additional cathode area for the glow discharge passing through the pinhole.

The results obtained show that the connection of the platinum area to the cathode through the resistance generally increased the ratio of the number of times that the cathode spot was set up on the annular area of the mercury pool to the number of times that it was set up within the funnel. The data obtained are plotted in Fig. 3; the lower curve was obtained without either of the platinum areas, and the upper curve was obtained by using the single platinum alloy area nearest to the cathode pool. It was also verified that the addition of the second patch raised the curve somewhat.

References

1. C. W. Lufcy and P. L. Copeland, *J. Appl. Phys.* **16**, 740 (1945).
2. P. L. Copeland, *Rev. Sci. Instr.* **16**, 154 (1945).

21 February 1955.

Communications

Demonstration of the Basicity of Water in Alcoholic Solutions

Experiments either designed or interpreted as determining the relative basicity of water versus alcohols have given contradictory answers. Hammett (*1*) points out that because charged acids such as ammonium ion have smaller pK_a values in ethanol than in water, one may conclude that the former is the more basic solvent. On the other hand, the same author cites references to colorimetric and acid catalyzed reactions that indicate the reverse. Hine and Hine (*2*), in reviewing the literature on both the relative acidity and basicity of water versus alcohols, also show that these evaluations depend on the system chosen for study.

The simplest way of assessing the relative magnitude of a given property of two substances is through a competitive situation. In studying the solvochromism (*3*) of alcoholic solutions of an indicator composed of propyl gallate and ferric chloride, we observed that the blue color of the chelate was promoted

Table 1. Compounds arranged in order of decreasing basicity.

Alcohol or miscellaneous compound	Indicator	Milliliters of water per 10 ml of solvent	Mole percent water
Isopropanol	2	0.01	0.42
1,4-Butylene glycol	2	0.03	1.5
sec-Butanol	2	0.08	3.9
t-Butanol	2	0.08	4.1
Ethylene glycol	2	0.15	4.4
t-Pentanol	2	0.11	6.2
Ethanol	1	0.03	0.97
n-Propanol	1	0.03	1.2
n-Butanol	1	0.03	1.5
Isobutanol	1	0.03	1.5
Diethyl carbinol	1	0.03	1.8
n-Hexanol	1	0.03	2.1
1,3-Butylene glycol	1	0.05	2.4
2-Ethyl butanol-1	1	0.04	2.7
Isopentanol	1	0.05	3.0
Methanol	1	0.14	3.1
Cyclohexanol	1	0.06	3.4
Propylene glycol	1	0.10	4.0
Triethyl carbinol	1	0.08	6.1
2,3-Butylene glycol	1	0.13	6.1
Acetonitrile	1	0.44	11.4
Ethylene glycol monoethyl ether	1	0.41	18.1
Ethylene glycol dimethyl ether	1	0.50	22.4
Acetone	1	1.07	30.4
Dioxane	1	2.21	51.3

by bases such as ammonia and many common aliphatic, aromatic, and heterocyclic amines whose pK_b values ranged from 3 to 12. On the other hand, strong protonic acids such as sulfuric, aliphatic and aromatic sulfonic, aromatic phosphonic, as well as Lewis acids like aluminum chloride, acetyl chloride, and acetic anhydride, repressed chelate formation, resulting in yellow solutions. The fact that the addition of between 0.3 to 1.5 volume percent water to various alcoholic solutions of the indicator was enough to bring about chelate formation demonstrates the behavior of water as a proton acceptor in the common alcohols studied.

Table 1 lists the alcohols in order of increasing mole percent of water that is just required to cause the appearance of the blue color of the chelate. It should be noted that the first six alcohols were titrated using an indicator acidified with acetyl chloride. The latter desensitized the indicator so that the blue color of the chelate was not evident in the more basic alcohols before the addition of water.

The indicator solutions were prepared as follows. For indicator 1, 2 gr of anhydrous ferric chloride and 4 gr of propyl gallate were codissolved in 100 ml of glacial acetic acid with the aid of heat. The color of the solution was a deep yellow brown. Indicator 2 was a duplicate of the first, except that 1 ml of acetyl chloride was added to the foregoing recipe. The color of the resulting solution was a yellow orange.

In each titration 3 drops (0.05 ml/drop) of indicator 1 was added to a 10-ml sample of an alcohol. If the resulting solution was yellow or light green, it was titrated to a blue end-point with water. In the case of the first six alcohols that were capable of turning indicator 1 blue without the addition of water, the more acidic indicator 2 was used in the same concentration. All the solvents were chemically dried and distilled. The fraction used boiled over a ½° range at worst. The average water content of six of the purified alcohols, as determined by the Karl Fischer method (*4*), was 0.05 percent.

Although the number of cases studied is meager, the data indicate a decrease in basicity with increasing molecular weight in a given series of alcohols. Thus, we have the following set of series.

Primary alcohols: ethanol > *n*-propanol > *n*-butanol > *n*-hexanol.
Secondary alcohols: isopropanol > 2-butanol > 3-pentanol.
Tertiary alcohols: *t*-butanol > *t*-pentanol > triethyl carbinol.

Methanol is the exceptional case in the primary alcohol series, in that it is much less basic than the other members studied. This anomaly is readily understandable because of the greater electronegativity of hydrogen over an alkyl group attached to a carbon atom. In the primary alcohol series, the decrease in basicity is fairly constant, each succeeding member requiring an increase of 0.3 mole percent water. Although the results show that the order for the isomeric butyl alcohols is *sec*-butanol > *t*-butanol > *n*-butanol, the value of 6.1 for triethyl carbinol against a calculated value of 2.4 for *n*-heptanol indicates that the order might be different for higher homologs.

A consideration of the extent of hydrogen bonding and the relative electronegativity of hydrogen versus an alkyl group is helpful in interpreting these results. There is some evidence from infrared spectroscopy that the more extensively a carbinol carbon is shielded by alkyl groups, the lower the degree of hydrogen bonding (*5*). It is a reasonable assumption that the basicity should increase with the degree of polymerization, because the acidic protons are held more tightly, thus offering less competition to an incoming proton. The order of basicity of the polymeric state of the alcohols should be primary > secondary > tertiary. On the other hand, because of the greater electronegativity of hydrogen compared with an alkyl group, the order of basicity in the monomeric state should be the reverse. The order in the isomeric butyl alcohols indicates that these effects are of comparable magnitude. However, in the butylene glycols, the order is 1,4-butylene glycol > 1,3-butylene glycol > 2,3-butylene glycol. Here, the extent of hydrogen bonding seems to be the controlling influence. It should be noted that the order of decreasing basicity is the same as that of decreasing boiling point, another

property whose magnitude is greatly influenced by the extent of hydrogen bonding. The same explanation suggests itself for the differences in the basicity and boiling point between ethylene and propylene glycols. The decrease in basicity with chain length in the monohydric alcohols follows from the increased forces between longer chains which in turn weakens the hydrogen bonds.

A few other compounds are cited in Table 1 in order to relate the basicity of the alcohols to other functionalities by the same yardstick.

We have found that indicator 1 is analytically useful for detecting water in alcohol samples. For example, "anhydrous," shelf samples of ethanol gave a light green color with this indicator. The water content was 0.3 to 0.5 percent and was found to be suitable for malonic ester condensations.

SAUL SOLOWAY
PERRY ROSEN
Department of Chemistry, City College of New York, New York, N. Y.

References

1. L. P. Hammett, *Physical Organic Chemistry* (McGraw-Hill, New York, 1940), pp. 260–262.
2. J. Hine and M. Hine, *J. Am. Chem. Soc.* **74**, 5267 (1952).
3. S. Soloway and P. Rosen, *Science* **121**, 3134 (1955).
4. S. Siggia, *Quantitative Organic Analysis via Functional Groups* (Wiley, New York, 1949), pp. 66.
5. L. N. Ferguson, *Electron Structures of Organic Molecules* (Prentice-Hall, New York, 1952), chap. 9.

11 March 1955.

Effect of Isonicotinic Acid Hydrazide on Some Plant Systems

Several months ago Wort (*1*) described some effects of the antitubercular compound isonicotinic acid hydrazide (INH) on the growth of certain higher plants when it was applied to the foliage of established seedlings. General retardation of top growth was observed with INH concentrations of 0.4 to 1.6 percent. INH solutions of the same concentrations applied to the soil similarly caused stunting, except at the 1.6-percent level, which was lethal to several species. Wort went further and showed that in oats, beans, and sugar beet seedlings, leaf catalase and phosphatase activities were depressed, although only slightly, by treatment with 1.2-percent INH (87 μM/ml).

Wort's experiments might suggest that plants are not particularly responsive to this compound, a conclusion that would be at variance with observations on other plant systems that are affected by far lower concentrations of INH. In 1952 Schopfer *et al.* (*2*) showed that a concentration of INH as low as 0.0039 percent in the medium would cause 50-percent reduction in elongation of pea roots in sterile culture, and that this effect was partially reversible by indoleacetic acid. Bustinza and Santamaria (*3*) reported that germination of seeds of *Raphanus sativus, Triticum compactum,* and *Lupinus alba* was completely prevented by 0.4-percent INH and that some inhibition of seedling development in these three species was evident at 200, 50, and 10 ppm, respectively (1.5 μM/ml, 0.36 μM/ml, and 0.07 μM/ml). On the other hand, Nickell and Findlay (*4*), using *Lemna minor* as the test system, found substantial stimulation of growth by 1 to 20 ppm INH (0.007 to 0.15 μM/ml, approximately) but did not record the effects of higher concentrations.

In experiments in these laboratories (*5*) this compound INH has been observed to be an active inhibitor of root growth. In aerated water cultures the roots of Moore barley seedlings grown for 5 days in the dark were inhibited to the extent of 50 percent on a dry weight basis by 350 ppm (2.55 μM/ml) INH presented 24 hr after the seeds were moistened. The roots, although not proportionately reduced in length, were distinctly yellow in color.

Similarly in the cucumber germination test of Ready and Grant (*6*), the elongation of the primary root of cucumber var. Early Fortune at 25° was inhibited 50 percent by a concentration of INH of 225 ppm (1.6 μM/ml). The response curve for Moore barley was almost coincident with that for cucumber at low INH concentrations, with the 50-percent inhibition point occurring at 220 ppm. Root elongation of Koto flax, however, was more sensitive to this compound. Fifty-percent inhibition was observed at 37 ppm (0.27 μM/ml). It is perhaps worthy of comment that in these root responses INH is about one-fifth as active as maleic hydrazide, which has found some uses as a growth regulator and growth repressant.

Top application of INH to young Black Valentine bean plants, either as droplets containing 50 or 100 μg to the base of a unifoliate leaf, or by immersing the unifoliate leaf in a solution of either $1 \times 10^{-3} M$ or $1 \times 10^{-4} M$ for 48 hr did not result in any detectable growth repression or morphological change. Only at much higher levels of application was growth repression evident, as is reported by Wort (*1*).

Thus it appears that INH, like numerous other compounds, has physiological potency in the inhibition of root growth and development at levels substantially lower than those that elicit any morphological responses in the tops of established plants. It is perhaps from the ranks of such compounds that materials suitable for preemergence weed control should be sought.

A. G. NORMAN
Department of Botany, University of Michigan, Ann Arbor

References and Notes

1. D. J. Wort, *Science* **120**, 72 (1954).
2. W. H. Schopfer, E. Grob, G. Besson, *Arch. sci. (Geneva)* **5**, 5 (1952).
3. F. Bustinza and M. L. C. Santamaria, *Antibiotics & Chemotherapy* **3**, 793 (1953).
4. L. G. Nickell and A. C. Finlay, *J. Agri. Food Chem.* **2**, 178 (1954).
5. This article is paper No. 5 from the Plant Nutrition Laboratory, Michigan Memorial Phoenix Project No. 32, of the University of Michigan.
6. D. Ready and V. O. Grant, *Botan. Gaz.* **109**, 39 (1947).

21 March 1955.

Use of "Personal Communications" in Scientific Reviews

The recent communications by C. Stern and A. L. Bacharach [*Science* **119**, 221 (1954); **121**, 313 (1955)] on citing unpublished articles prompt me to touch on another aspect of this problem: the frequent inclusion by reviewers of scientific literature of "personal communications" from authors whose work has not been published at the time the review is being written. I wish to emphasize that my remarks are directed not at authors of papers reporting original investigations, for whom "personal communications" may serve diverse functions, but at authors of scientific reviews, particularly of those that appear with calendar regularity. For them the disadvantages of including "personal communications" seem to outweigh the advantages.

The *Annual Review of Plant Physiology* has recently eliminated the use of "personal communications." The invitations to authors include a statement that

> . . . reviews should deal with published work only, with the sole exception of papers in press at the time the review article is submitted. A paper in press is defined as one accepted and not merely submitted for publication in a scientific journal whose name must be cited in the bibliography. It is permissible, however, to cite doctors' or masters' theses on file in a university library and papers actually presented (but not read by title only) at scientific meetings.

The arguments for including "personal communications" are chiefly that they give the reader access to the most recent developments in the field and contribute materially to the timeliness and freshness of the review. The arguments on the other side are, first of all, that the reader is denied the opportunity he rightly expects of being directed to the original evidence for an independent appraisal of its significance. When confronted with a "personal communication," the reader must either accept or reject its evaluation by the reviewer usually without himself having a sufficient basis of fact in either case.

The inclusion of "personal communications" in reviews poses a special problem when these pertain to new findings in an active field of research. A reviewer may be informed about unpublished findings made by workers known to him personally. Similar or even better founded evidence may have been in the hands of other workers unknown to the reviewer. The inclusion of "personal communications" from some workers prior to the normal publication of data would thus record in the scientific literature a priority of discovery in a sequence not always warranted by the facts.

Another shortcoming of "personal communications" is that they pertain to material which, being unpublished, has not been subjected to the scrutiny of editors and readers or, in the case of oral presentations at scientific meetings, of fellow-scientists in attendance. There is thus no way to judge whether a particular conclusion reached by the originator of a "personal communication" is well documented and merits serious consideration. It is conceivable that the use of "personal communications" may, if not checked, engender in certain individuals hazardous drawing of conclusions from insufficient evidence. If the idea were proved to be correct by subsequent and more extensive work, often by others, the "wager" would be won, whereas if the idea proved to be incorrect it might be expected to be easily forgotten.

These remarks are not intended to suggest that "personal communications" are necessarily unreliable but rather to stress the special problems that their use in reviews creates. "Personal communications" weaken the readers' prerogative of independent evaluation of the material cited by the reviewer.

DANIEL I. ARNON, *Editor*
Annual Review of Plant Physiology,
University of California, Berkeley

21 April 1955.

Arnold Arboretum Controversy

With reference to the news item [*Science* **121**, 416 (25 Mar. 1955)] stating that the controversy over the Arnold Arboretum of Harvard University has been settled, I have the following comments to make.

1) The controversy over the Arnold Arboretum has not been finally resolved. The *Harvard Alumni Bulletin* of 26 Feb. 1955, which is quoted in part in the news item, concedes that the controversy has merely come to "the end of a chapter."

2) It seems to beg the question to say that the removal of the bulk (about six-sevenths) of the library and herbarium from Jamaica Plain to Cambridge provides "more accessible quarters" for these components of the Arboretum. From the standpoint of the botany department at Harvard, these resources are more accessible, of course; but from the point of view of the Arboretum as it has developed into an integrated whole at Jamaica Plain, these books and specimens are inaccessible indeed.

3) The statement in *Science* regarding the decision of the Supreme Judicial Court in *Ames vs. Attorney General,* 11 Feb. 1955, is, I fear, misleading, in that it suggests that the Attorney General has authority to pass upon the question of whether or not there is a breach of trust. Only a Court of Equity can make such a determination. The *Ames* case merely decided that the Attorney General's decision regarding the use of his name in a petition for a declaratory decree as to the existence of a breach of trust was not reviewable by the Court. This is by no means the same thing as saying that the Attorney General himself has authority to issue a binding decree that a breach of trust does or does not exist.

4) The item in *Science* quotes the Court's summary of the Attorney General's decision and states that the Court allows the Attorney General's decision to stand. This conveys to the average reader the impression that the Court has confirmed the findings

or views of the Attorney General. Such is not the case. The Supreme Judicial Court did not examine the merits of the question of whether or not the Harvard Corporation was engaged in a breach of trust and did not sustain the Attorney General in his statement that there was no breach of trust. The Court stated that the action of the Attorney General in not lending his name to a suit was a purely executive decision and not subject to review by the Court.

On 15 Apr., the Association for the Arnold Arboretum, Inc., an independent organization of more than 1000 members from all parts of the United States and Canada, having no connection with Harvard and being opposed to Harvard's present plan for the Arnold Arboretum, issued a 12-page pamphlet entitled *A Review of the Arnold Arboretum Controversy*. Readers who wish to understand the persistent issues of this controversy may receive a copy by writing to our office, 50 State Street, Boston 9, Mass.

THOMAS V. RANKIN, *Executive Secretary*
Association for the Arnold Arboretum, Inc.

29 April 1955.

Role of Nitrogen Oxides in Formation of Engine Deposits

Although the presence of oxides of nitrogen in exhaust gases from automotive engines has long been recognized (*1*), the importance of nitrogen fixation with respect to engine deposits seems to have been overlooked. We have studied kinetically the extent to which the reaction

$$N_2 + O_2 \rightleftarrows 2NO$$

can take place during the operation of a gasoline engine; from the study it has been calculated that, under normal engine conditions, the temperature is sufficiently high and sufficient time is available for the formation of an appreciable amount of nitric oxide. Furthermore, we have shown by engine tests that the quantity formed is dependent upon the operating variables that affect time, temperature, and concentration of gases within the flame. Oxides of nitrogen are found in increasing amounts in exhaust gases as leaner air-fuel mixtures, higher loads, and increased spark advance (up to the point of maximum power) are employed; nitrogen oxide (measured as nitrogen dioxide) up to 0.8 percent by volume of the exhaust gas has been encountered (*2*).

We have observed also that oxides of nitrogen are reactants in the formation of low-temperature engine varnish. Their importance in varnish-forming reactions was strongly indicated in advance by the fact that analyses showed nitrogen to be present in appreciable amounts in hundreds of deposit samples taken from engine locations exposed to combustion gases. More nitrogen was present than could be accounted for by the natural nitrogen content of the fuel and lubricant or by that contained in the additives that might have been used. Chemical and spectral tests indicate that the bulk of the nitrogen in these engine deposits is in the form of aliphatic nitro groups.

A striking demonstration of the part played by oxides of nitrogen in varnish-forming reactions was effected by operating a test engine under low-temperature varnish-forming conditions with an artificial atmosphere composed of oxygen and carbon dioxide; varnish deposits were not formed. When, however, sufficient nitrogen dioxide was added to the artificial atmosphere to give a concentration approximating that usually found in exhaust gas, heavy varnish deposition took place. Variations on this experiment have confirmed these results.

Although varnish formed under low-temperature conditions appears to result from primary reactions involving either raw or partially oxidized fuel components and oxides of nitrogen contained in blow-by gases, further work indicates that at high operating temperatures varnish formation can, when certain oils are used, proceed in absence of nitrogen dioxide. Tests have been made with a stable nonvarnish-forming fuel and the oxygen-carbon dioxide atmosphere under engine conditions that caused severe oil deterioration. When a relatively unstable lubricating oil was employed with this combination, piston varnish was deposited. This suggests that engine varnishing may be attributed to at least two possible causes. (i) reactions between fuel materials and nitrogen dioxide when the engine is operating at a low coolant and oil temperature; (ii) oxidation reactions of unstable lubricating oils when the engine is operating under high-temperature conditions. Combinations of these mechanisms is obviously possible.

R. S. SPINDT
COURT L. WOLFE
DONALD R. STEVENS
Gulf Research and Development Company Multiple Fellowship, Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pennsylvania

References and Notes

1. A. C. Egerton and T. K. Hanson, *Proc. Roy Soc. London* **A163**, 90 (1937).
2. Details of the analytic method employed will be submitted elsewhere for publication.

21 March 1955.

SAUNDERS BOOKS

New (2nd) Edition!

Turner -

GENERAL ENDOCRINOLOGY

This text views endocrinology as a basic biological science. The phenomenon of internal secretion is considered as it extends throughout the whole range of animal and plant life.

In this *New (2nd) Edition* all chapters have been revised thoroughly with many new references applying to current literature. Discussions on the adrenal cortex and pituitary gland have been rewritten to include recent research. More space has been devoted to neurosecretion and new chapters added on *Principles of Endocrinology, Adaptive Reactions to Stress* and *Endocrine-like Mechanisms.* Sections on biochemistry have been expanded and presented at the beginning of each chapter. New illustrations have been added depicting endocrine disorders in man and other animals.

By C. DONNELL TURNER, Ph.D., Lecturer in Biology, Tokyo Army Education Center, Tokyo, Japan. 553 pages, 6" x 9", with about 349 illustrations. *New (2nd) Edition—Just Ready!*

New!

Willier, Weiss and Hamburger -

ANALYSIS OF DEVELOPMENT

This collaborative work is a modern synthesis of our knowledge of the principles and mechanisms of animal growth and development. It emphasizes the dynamic and causal aspects of embryogenesis. Each of the 28 contributors, all eminent embryologists, has given an argumentative presentation of his topic, clearly outlining the general problems, concepts and lines of investigation and illustrating them with selected examples from experimental data.

An historical survey of problems, cytology, cell division, the formation of gametes, fertilization, vertebrate organogenesis of particular systems of the body, progressive differentiation and energy exchange are some of the topics covered.

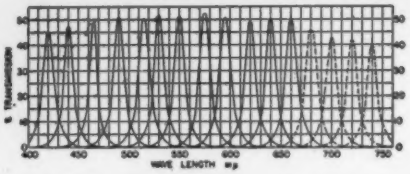
Edited by BENJAMIN H. WILLIER, Professor of Zoology, Johns Hopkins University, Baltimore, Maryland; PAUL A. WEISS, Member Rockefeller Institute for Medical Research, New York; and VIKTOR HAMBURGER, Professor of Zoology, Washington University, St. Louis, Missouri. 735 pages, 7" x 10", with 248 illustrations. $15.00. *New!*

W. B. SAUNDERS COMPANY

West Washington Square — Philadelphia 5

BALZERS Interference Filters

for isolating narrow spectral bands



Spectral Range: 400-900 millimicrons
Spectral Width: 12-15 mμ, Transm.: 45-50%
Size: 2" x 2". Other sizes on order.

For
Flame Photometry and Color Densitometry
Microscopy and Photomicrography
Colorimetry and Fluorimetry

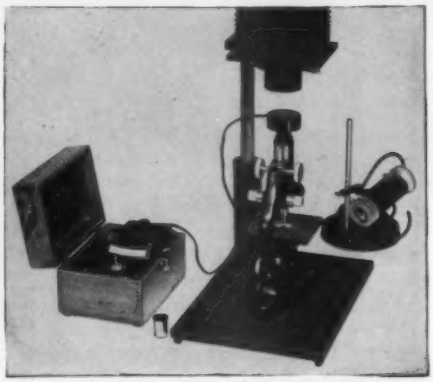
also in reflectometry, light scattering measurements, microcolorimetry, refractometry, polarimetry, and in all other fields requiring monochromatic light in the visible and near-infrared range.

Write for Bulletin #180 to

PHOTOVOLT CORP.
95 Madison Ave. New York 16, N. Y.

PHOTOVOLT

Exposure Photometer Mod. 200-M
for
PHOTOMICROGRAPHY

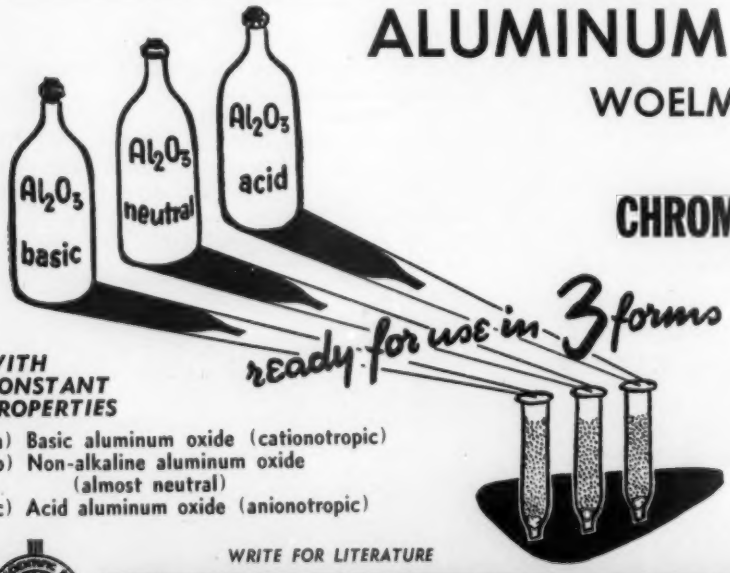


Accurate determination of exposure time in black-and-white and color photomicrography

Write for Bulletin #810 to Price $92.00

PHOTOVOLT CORP.
95 Madison Ave. New York 16, N. Y.

ALUMINUM OXIDE
WOELM
For
CHROMATOGRAPHIC ANALYSIS



WITH CONSTANT PROPERTIES

(a) Basic aluminum oxide (cationotropic)
(b) Non-alkaline aluminum oxide (almost neutral)
(c) Acid aluminum oxide (anionotropic)

WRITE FOR LITERATURE

STANDARD SCIENTIFIC SUPPLY CORP.
34 West 4th Street • New York 12, N. Y.

fills every research requirement

Leitz **ORTHOLUX** RESEARCH MICROSCOPE

IDEAL FOR RESEARCH—The Leitz *ORTHOLUX* microscope is highly valued in leading research laboratories because of its versatility, image quality and unique advantages. The *ORTHOLUX* incorporates the most refined details of advanced optical design and has its own *built-in* illuminating system for transmitted or incident light.

WITHIN SECONDS the *ORTHOLUX* with easily attached Leitz accessories adjusts for: bright and dark field • polarized light • phase contrast • fluorescence microscopy • photomicrography • table and wall projection • ultrapak illumination for reflected light.

COMFORT AND EASE OF OPERATION—*ORTHOLUX* design permits operation of the microscope in a relaxed position with unobstructed stage in clear view and fingertip control of low position, table-top adjustment knobs. And . . . the dual controls move only the ball-bearing stage—they do not alter the favorable eyepiece height—providing fatigue-free operation.

Send for *ORTHOLUX* brochure.
See and examine the
ORTHOLUX microscope soon.

E. Leitz, Inc., Dept. SC-6
468 Fourth Ave., New York 16, N. Y.

Please send me the Leitz *ORTHOLUX* brochure.

Name_____

Street_____

City_____ Zone____ State_____

09455

E. LEITZ, INC., 468 FOURTH AVENUE, NEW YORK 16, N. Y.
Distributors of the world-famous products of Ernst Leitz, Wetzlar, Germany
LENSES • CAMERAS • MICROSCOPES • BINOCULARS

SCIENCE is published weekly by the AAAS, 1515 Massachusetts Ave., NW, Washington 5, D. C. Entered at the Lancaster, Pa., Post Office as second class matter under the act of 3 March 1879. Annual subscriptions: $7.50; foreign postage, outside the Pan-American Union, $1; Canadian postage, 50¢.

HORMONE ASSAYS

ACTH • Growth • Gonadotropes
Estrogens • Androgens
Corticoids • Progesterone
Others

HYPOPHYSECTOMIZED RATS

•

ENDOCRINE TOXICITY TESTS

Write for details

ENDOCRINE LABORATORIES OF MADISON, INC.

5001 W. BELTLINE HIGHWAY • MADISON, WISCONSIN

LaMOTTE

COMBINATION SWIMMING POOL SET

for small pools and those who do not care to install separate units for chlorine and alkalinity.

This unit is applicable to the ranges of chlorine and alkalinity actually required for swimming pool water, and will enable the operator to keep his alkalinity and chlorine values between the limits required by State Health Department specifications.

They are complete with 3 color standards for each test representing the upper and lower limits of chlorine (0.2, 0.5, 0.7) and alkalinity (pH 7.2, 7.6, & 8.0) together with reagents and necessary glassware.

These units are contained in a plastic comparator block, the top of which serves for making tests. The plastic blocks are moisture resistant and ideal for use around pools.

LaMotte Chemical Products Company
Dept. "H" Towson, Baltimore 4, Md.

Here are the

PRECISION

10%

REPLACEMENT ALLOWANCE

Constant Temperature Replacement Items

BATHS
Carbon Residue, Conradson, ASTM D524
Demulsibility of Lubricants, Appendix 6
General Purpose, Glass, Aquarium Type
General Purpose, Glass, Economy Model
General Purpose, Glass, With Motor Stirrer
General Purpose, Metal, With Motor Stirrer
General Purpose, Metal, Rectangular, Freas
General Purpose, Metal, Rectangular, Freas With Motor Stirrer
Oxidation of Grease, Norma Hoffman, ASTM D942
Oxidation of Lubricants, Indiana
Oxidation of Lubricants, Sligh
Oxidation of Transformer Oil, ASTM D1314
Oxidation of Steam Turbine Oil, ASTM D943
Rust Prevention Tester, ASTM D665
Serological
Serological, Clinical
Serological, Army Medical
Soil Hydrometer Jar, ASTM D422
Vapor Pressure, Reid, 3 Bomb Model, ASTM D323
Viscosity, Kinematic, DeLuxe Model, ASTM D664
Viscosity, Saybolt, 2 tube Model, ASTM D664
Utility—Serological
Warburg
Warburg, Refrigerated

CABINETS
Corrosion Test, Army, Navy, H792
Humidity, Steel, enameled finish
Humidity, Stainless Steel finish
Low Temperature

CIRCULATING SYSTEM
Temptrol

FURNACES
Carius Combustion Tube, steel, enameled finish, 4 tube
Carius Combustion Tube, Stainless Steel finish
Muffle

GREASE TESTING APPARATUS (Other than Baths)
Roll Tester, Mil-Shel, GI 0924
Wheel Bearing Tester, ASTM D1263

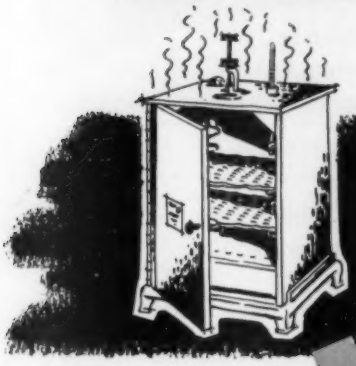
INCUBATORS, OVENS, STERILIZERS
Gravity Convection, Freas, Steel, enameled finish
Gravity Convection, Freas, Stainless Steel finish
Gravity Convection, Thelco, Steel, enameled finish
Asphaltic Compounds, ASTM, Steel, enameled finish
Asphaltic Compounds, ASTM, Stainless Steel finish
Coal Moisture, ASTM D271
Conditioning, Gravity, Convection, Freas, Steel, enameled finish
Conditioning, Mechanical Convection, Freas, Steel, enameled finish
General Purpose, Gravity Convection, Freas, Steel, enameled finish
General Purpose, Gravity Convection, Freas, Stainless Steel finish
General Purpose, Mechanical Convection, Freas, Steel, enameled finish
General Purpose, Mechanical Convection, Freas, Stainless Steel finish
General Purpose, Mechanical Convection, Freas, Steel, enameled finish, Explosion Proof
General Purpose, Mechanical Convection, Freas, Stainless Steel finish, Explosion Proof
Vacuum, Freas, Cylinder 9x9", Steel, enameled finish
Vacuum, Freas, Cylinder 9x9", Stainless Steel finish
Vacuum, Freas, Cylinder 9x18", Steel enameled finish
Vacuum, Freas, Cylinder 9x18", Stainless Steel finish
General Purpose, Gravity Convection, Freas, Hazard Safe, Steel, enameled finish
General Purpose, Gravity Convection, Freas, Hazard Safe, Stainless Steel finish
General Purpose, Mechanical Convection, Freas, Hazard Safe, Steel, enameled finish
General Purpose, Mechanical Convection, Freas, Hazard Safe, Stainless Steel finish
General Purpose, Gravity Convection, Thelco, Steel, enameled finish
General Purpose, Gravity Convection, Thelco, Transite
Vacuum, Thelco, Rectangular
Gas Heated (Sterilizer)

Precision Scientific Company
3739 West Cortland Street • Chicago 47

MORE THAN 10 YEARS OLD?

Is your car 10 or more years old? Probably NOT! When an automobile begins to indicate its age, it's usually replaced. Not because it isn't functioning—but because it MIGHT cause trouble just at the wrong time. Age always takes its toll eventually.

What About the Future? **Age plus hard usage in an atmosphere that is usually corrosive, plus the factor of extreme heat, is normally conducive to accelerated deterioration.**



Can You—with Confidence—Face Future Requirements with Your Old Equipment—This Year?—Next Year?

If not—Take Advantage of this Timely Offer—The First of Its Kind to the Laboratory

10% ALLOWANCE for REPLACED EQUIPMENT

For the first time, special consideration has been given to assist you in the problem of replacement of your laboratory equipment. To enable you to supplant your old with new CONSTANT TEMPERATURE Equipment, Precision Scientific Co. is making a "special-purpose" offer of a 10% ALLOWANCE (off the purchase price of the new equipment) for any equipment you replace from the items listed in this advertisement. But you must act promptly because the offer expires September 30th.

Remember These Facts

1. This offer is made for replacement of all listed Constant Temperature equipment — regardless of make.
2. You can supplant your old CONSTANT TEMPERATURE equipment at SUBSTANTIAL SAVINGS.
3. This 10% Allowance offer is made on 137 individual items.
4. This offer expires September 30th, 1955.
5. You can *always* depend on Precision equipment.

Here's How You Get Your Allowance

1. Check the list on preceding page for replaceable equipment you need.
2. Determine the number of items.
3. Use the coupon below to request your certificate — one certificate per item.

Precision Scientific Company

Compare These With Your Own Old Equipment

PRECISION SCIENTIFIC COMPANY, 3739 West Cortland Street • Chicago 47, Illinois

☐ Please send me the listing of 137 individual items together with prices and savings.

☐ Please send me _____ 10% Allowance Certificates.

COMPANY NAME.....

INDIVIDUAL.....

ADDRESS.....

CITY.....ZONE....STATE.....

low cost synthetic control serum

LAB-TROL

by Dade Reagents, Inc.

for accuracy control in blood chemistry tests

LAB-TROL is a sterile, synthetic serum of known value for checking common blood chemistries: total protein, glucose, NPN, blood urea nitrogen, chlorides, calcium-total, sodium, potassium, etc. Of major importance, LAB-TROL values remain constant and stable for an indefinite period of time.

LAB-TROL is run in parallel with unknown samples to check the accuracy of test and technique. If results do not coincide with known values of LAB-TROL, the instrument reagents or procedure should be rechecked.

LAB-TROL also contains human syphilis reagin (antibody), designed for test with antigens—gives (4+) reactions. It is packaged 12 vials (3.5 ml per vial producing approximately 30 cc's of filtrate) at $18.00 per package.

Scientific Products Division
AMERICAN HOSPITAL SUPPLY CORPORATION

New York · Chicago · Kansas City · Minneapolis · Atlanta · Washington · Dallas · Los Angeles · San Francisco

KLETT ELECTROPHORESIS

CUSTOM MADE

TOOL FOR THE ANALYSIS
OF COMPLEX COLLOID SYSTEMS, AND FOR
THE CONTROL OF PRODUCTION OF
PURIFIED PROTEINS, ENZYMES, HORMONES

KLETT MANUFACTURING CO.
179 EAST 87TH STREET
NEW YORK, N. Y.

A. J. Nerad joined the Chemistry Department at the General Electric Research Laboratory in 1924 and has been manager of the *Mechanical Investigations Section* since 1948. His fields of interest are fluid mechanics, heat transfer, liquid metals, combustion, and superpressures. Last February it was announced that his group had produced man-made diamonds.

Jets and diamonds

Research by A. J. Nerad, versatile General Electric scientist, has led to widely diversified results

Tony Nerad is a name well known to engineers and scientists who design jet aircraft. Even before the U.S. had entered World War II, he had started on research that led to the development of a new kind of jet combustor. The combustor – simple, compact, and reliable over wide variations in combustion conditions – helped make possible one of the earliest American-designed turbojets. The contributions made by Nerad were battle-tested in Korea, and are important factors in maintaining the high prestige of U.S. jets today.

Recently Nerad helped to make dramatic news again. The General Electric Research Laboratory announced that he had led the team of scientists which produced man-made diamonds. Thirty years of research experience – work on jet combustors, liquid metals, and other projects – enable Tony Nerad to extend this promising area of *superpressure* research. This G-E research in high temperatures and high pressures demonstrates again that expanding our research program – and creating promising opportunities for scientists – contributes to progress.

Progress Is Our Most Important Product

GENERAL ELECTRIC

RESEARCH BIOCHEMICALS
OF
HIGHEST POSSIBLE PURITY

FOR
INVESTIGATIONAL
USES

AMINO ACIDS

A complete selection of more than 100 Amino Acids

Pre-tested for rigid specification adherence to assure highest possible purity for exacting requirements of Biochemical Research.

Typical Amino Acids

GAMMA AMINO BUTYRIC ACID
ASPARAGINE, D, DL, L
CANAVANINE SULPHATE
DL CITRULLINE
DL DIHYDROXYPHENYLALANINE
GLUTAMINE
HOMOCYSTEINE
HYDROXY-L-PROLINE
METHIONINE, D, DL, L
METHIONINE, SULFONE, SULFOXIDE
PHENYLALANINE, D, DL, L
SERINE, D, DL, L
THREONINE, D, DL, L
TRYPTOPHANE, D, DL, L
VALINE, D, DL, L

WRITE FOR NEW CATALOG
(May 1955)
OVER 1500 ITEMS

NUTRITIONAL BIOCHEMICALS
CORPORATION
21010 MILES AVENUE • CLEVELAND 28, OHIO

OPTICALLY ACTIVE AMINO ACIDS

D-ASPARTIC ACID
L-ASPARTIC ACID
D-SERINE
L-SERINE
D-THREONINE
L-THREONINE
D-TRYPTOPHAN
L-TRYPTOPHAN
D-VALINE

Winthrop-Stearns INC.
SPECIAL CHEMICALS DIVISION
1450 Broadway, New York 18, N. Y.

NOW OVER **5100** CHEMICALS
BIOS

- Diiodolecithin
- 3,5-Diiodothyronine Hydrochloride
- 1,2-Dimercaptopropane
- 2,3-Dimercapto-propionic Acid
- 3,4-Dimethylbenzoic Acid
- Dimethylcarbamyl Chloride
- 2,2-Dimethylethyleneimine
- 1,1-Dimethylethylene Oxide
- 1,2-Dimethyl-napthalene
- 1,5-Dimethyl-napthalene
- 5,6-Dimethyl-1,10-phenanthroline
- Dimethylpyrone
- 2,4-Dimethylpyrrole
- 2,5-Dimethylpyrrole
- 2,4-Dimethylquinoline
- Dimethyltelluronium Diiodide
- 2,6-Dimethylthianthrene
- 2,4-Dimethylthiazole
- Dimethyl Zinc
- α,α'-Dinaphthyl
- β,β'-Dinaphthyl
- 2,2-Dinitrodiphenyl
- 4,4'-Dinitro-1,1'-binaphthyl
- 1,5-Dinitronaphthalene
- 1,8-Dinitronaphthalene
- 1,6-Dinitro-2-napthol
- 2,6-Dinitrophenol
- β-Diolein
- 4,4'-Diphenylbiphenyl
- Diphenylcarbamyl Chloride
- Diphenyldichlorosilane

Ask for our new complete catalogue

BIOS *Laboratories Inc.*
17 West 60th St. New York 23, N. Y.
PLaza 7-8171

AAAS EDITORIAL BOARD

Dael Wolfle
Acting Editor

Charlotte V. Meeting
Assistant Editor

Mark H. Adams
William R. Amberson
Wallace R. Brode
Bentley Glass
Karl Lark-Horovitz
Edwin M. Lerner
William L. Straus, Jr.

Advertising Representative: F. A. Moulton

American Dairy Science Association

A New Affiliated Society of the AAAS

THE American Dairy Science Association was organized as the National Association of Dairy Instructors and Investigators on 17 July 1906 at the University of Illinois. The proceedings and program of this meeting were published as an Illinois Experiment Station circular in 1907. W. J. Frazer, University of Illinois, was one of the early leaders in the development of the association. The meetings were usually held in connection with the National Dairy Show. In 1917 the official name was changed to the American Dairy Science Association. There are now three sections: Dairy Production, Dairy Manufacturing, and Dairy Extension. Each section has a chairman, vice chairman, and a secretary.

To date 49 annual meetings have been held. The first summer meeting was held at Michigan State College in 1927. Since then the annual meetings have been held during early summer at one of the agricultural colleges. It is of interest that the 50th annual meeting of the association will be held at Michigan State University, 21–23 June. The advent of the summer meetings marked the beginning of a rapid increase in growth of the association. There are approximately 1750 members in the association, and last year 700 attended the meeting at Pennsylvania State University. Many members bring their families to the annual meetings as part of their summer vacation program.

Membership in the association is open to those who have educational background equivalent to university training in dairy science and technology and who are engaged directly or indirectly with the dairy industry. This includes administrative positions in government, colleges, and industry, teachers, dairy plant operators, farm managers, and others with technical or scientific responsibilities in allied industries.

The objects of the association are (i) to stimulate scientific research in all phases of interest to the dairy industry and dairy science, (ii) to improve dairy instruction in schools, colleges, and extension services, (iii) to cooperate in educational activities for the advancement of the dairy industry, and (iv) to make available through the *Journal of Dairy Science*, the official journal, the results of original scientific dairy research, new developments in the technologies applicable to the dairy field, economic information, and news and comments of interest to dairy workers. The association maintains an active interest in students and has 25 affiliate groups located at various colleges. It has many active committees working with industry and scientific groups on problems of mutual interest.

The association has an extensive award program for outstanding achievement. Awards of $1000 are given each year through the sponsorship of allied industry organizations. The awards are for outstanding research contributions in dairy production, dairy manufacturing, and dairy cattle nutrition. Awards are also given to the outstanding teacher in dairy science and to the outstanding man in extension work.

The *Journal of Dairy Science* is published once a month. Each volume for the year contains about 150 scientific articles in a total of about 1200 pages. The editor, P. H. Tracy of the University of Illinois, is assisted by a 10-man editorial board. Each member receives a subscription to the journal.

The association's executive board is composed of seven directors, the president, vice president, and secretary-treasurer. Officers for this year are president, L. A. Moore, Agricultural Research Service, USDA; vice president, I. A. Gould, Ohio State University; secretary-treasurer, T. D. Harman, Ohio State University.

L. A. MOORE

Beltsville, Maryland

SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at Business Press, Lancaster, Pa. SCIENCE is indexed in the *Reader's Guide to Periodical Literature*.

All correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D. C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors.

Change of address: The notification should reach us four weeks in advance. If possible, please furnish an address stencil label from a recent issue. Be sure to give both old and new addresses, including postal zone numbers, if any.

Annual subscriptions: $7.50; foreign postage, outside the Pan-American Union, $1.00; Canadian postage, 50¢. Single copies 25¢. Special rates to members of the AAAS.

Cable address: Advancesci Washington.

The AAAS also publishes THE SCIENTIFIC MONTHLY.

SEE BETTER . . .
MORE EASILY

WITH SCIENCE'S FINEST

3-D MICRO-VISION

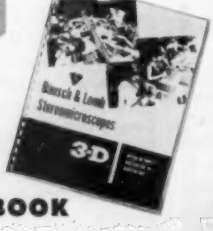
Only Bausch & Lomb Stereomicroscopes *can* give you such clear, sharp views, vividly magnified in natural 3-dimensional detail . . . such relaxed ease throughout prolonged examinations. Because only Bausch & Lomb gives you the finest optical system ever produced for wide-field work . . . in a complete line of models comfort-tailored to every need.

SHOCKPROOF . . . for lifetime dependability

Ready whenever you need it . . . in the lab or in the field . . . because prisms *can't* jar loose despite the punishment of year-after-year practical use. Double support locks them into lifelong alignment . . . clamps at the top, gibs at the bottom.

DUSTPROOF . . . for bright, detailed images

Even on field trips, you get "laboratory clean" images. Patented Neoprene ring inside prism housing fits flush on prism surface, seals out dust . . . one of the reasons why B&L Stereomicroscopes are *dustproof for life.*



Write today for

3-D MICRO-VISION BOOK

- See actual stereo views!
- Fit exact model to specific study needs, with unique Selector-Chart!

For your *free* copy of Manual D-15, write to Bausch & Lomb Optical Co., 64267 St. Paul St., Rochester 2, N. Y.

STEREOMICROSCOPES

BAUSCH & LOMB

SINCE 1853

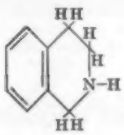
America's only complete optical source . . . from glass to finished product.

Kodak reports to laboratories on:

pedantry about a reduced quinoline . . . a nice width for film . . . red light and recording film

Which way is up?

He is arguing that theoretically *1,2,3,4-Tetrahydroisoquinoline* (Eastman 7065) should exhibit *cis-trans* isomerism. It's a compound just added to our list at the request of a gentleman with startling ideas about reduced quinolines. Without gestures it may be written thus:



The fellow in the picture is representing the planes of the two rings by his palms and letting the pencil stand for the N-H bond. He claims there should be two possibilities: either the pencil sticks up between his thumb and forefinger, or it sticks down. The former is the *cis* isomer and the latter the *trans*, he says. We say he's all wet. Just because we have succeeded in separating trans-*Decahydroquinoline* (Eastman 6480) out of the *cis-trans* mixture of *Decahydroquinoline* which we list as Eastman 5576, we don't think it's possible to pull the same stunt when there are no asymmetric carbon atoms. Do you?

In our List No. 39 there are some 3500 other chemicals also that can serve as raw material for research and debate. A free copy can be obtained by writing Distillation Products Industries, Eastman Organic Chemicals Department, Rochester 3, N. Y. (Division of Eastman Kodak Company).

70mm

70mm is a nice width for film—big enough to do with moderate magnification or none at all; small enough for economy in equipment size, in film record storage space, and in raw film cost. As these advantages strike more and more technical users of photography, we have come to keep the following black-and-white films generally available in 70mm width for prompt delivery:

Kodak Tri-X Film—The iconoclastic new one, with so much speed and latitude that right and left it shatters shibboleths about how, when, and where pictures may or may not be taken.

Kodak Plus-X Film—For situations where very fine grain in the negative is worth more than extreme sensitivity.

Kodagraph Micro-File Film—Higher resolving power, more contrast, and higher maximum density (all valuable attributes for document copying), at the expense of beauty in tone rendition.

Kodak Linagraph Shellburst Film—Special characteristics for photographing objects against a bright sky.

Kodak Photoflure Film—For photography from fluorescent screens, as in mass chest x-ray surveys. Available in blue-sensitive and green-sensitive types.

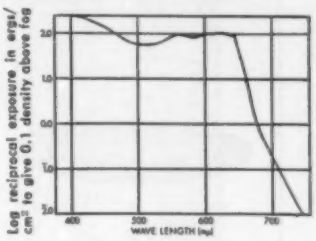
On 70mm color film, we can't be quite so prompt, but if you'll place an order for 14 rolls of 70mm *Kodak Ektachrome Film*, we'll put it up just for you. Since with this film you make your own processing arrangements, it can be examined as full-color transparencies 65 minutes after it leaves the camera.

For details on perforation and spooling of 70mm films, just write Eastman Kodak Company, Rochester 4, N. Y. Your letter will reach the right desk all right.

"Linagraph": its meaning

This is a warning to anyone who constructs a hood out of clear red plastic to permit watching a cathode-ray display while it is being photographed, as suggested by a recent helpful hint in *Science* on electrophysiological recording: watch out. The premise, "since Linagraph paper and film are both insensitive to red light," is defective. Linagraph Paper and *some* Linagraph Film are insensitive to red; but *Kodak Linagraph Pan Film*, the film most likely (on the basis of our sales figures) to be in your recording camera, is sensitive to red even more, proportionally, than the human eye.

Here is its spectral response:



Even now we are getting ready a faster Linagraph film than this, and most assuredly that too will have red sensitivity. With c-r beams writing at hundreds of inches per microsecond, sensitivity is what you dearly want in a film. Moreover, there are cases where the longer wavelength portion of the sensitivity serves specifically to record the persistent component of the emission from some phosphors.

Kodak Linagraph Ortho Film, the second best seller, has negligible red sensitivity so that it should require no filter to remain unaffected by the reddish cathode glow.

No hard feelings, of course. What if a product naming committee of a large manufacturing firm does devise a word like "Linagraph" as a trade-mark to cover the firm's whole diverse group of instrument-recording films and papers? Users of the products who find that word on non-red-sensitive film or paper can hardly be blamed for using it to identify these materials when writing for colleagues about their use. On the contrary, they ought to be thanked and hereby are.

For nothing more than the trouble of writing Eastman Kodak Company, Graphic Reproduction Division, Rochester 4, N. Y., anyone can get a pamphlet that gives all the tedious but helpful facts about Kodak Linagraph Films and Papers.

This is one of a series of reports on the many products and services with which the Eastman Kodak Company and its divisions are . . . *serving laboratories everywhere*

Kodak
TRADE-MARK

Automatic

INOCULATING INSTRUMENT

Designed to reduce the labor required for mass inoculation. It is not necessary to refill the syringe, as the total volume that may be injected is governed not by the capacity of the syringe, but by the capacity of the vaccine bottle or vial.

The use of a bacterial filter permits only sterile air to displace the fluid removed from the vaccine bottle. The foot injection apparatus permits a greater dexterity of operation to the operator. Fixed amounts of fluid may be injected without need of periodically observing the volumes in the inoculating instrument.

Catalog No. 49-718 **$85.00**

PHIPPS & BIRD, INC.
Manufacturers & Distributors of Scientific Equipment
6th & Byrd Streets - Richmond, Va.

BIND 'EM... and you'll find them!

Keep your copies of SCIENCE always available for quick, easy reference in this attractive, practical binder. Simply snap the magazine in or out in a few seconds—no punching or multilating. It opens FLAT—for easy reference and readability. Sturdily constructed—holds 26 issues.

This beautiful maroon buckram binder stamped in gold leaf will make a fine addition to your library. Only $2.75 postpaid (personal check or Money Order please). Name, 75¢ extra—year of issue, 50¢ extra. ORDER YOURS NOW!

SCIENCE • 1515 Mass. Ave., N.W., Washington 5, D. C.

there must be a reason

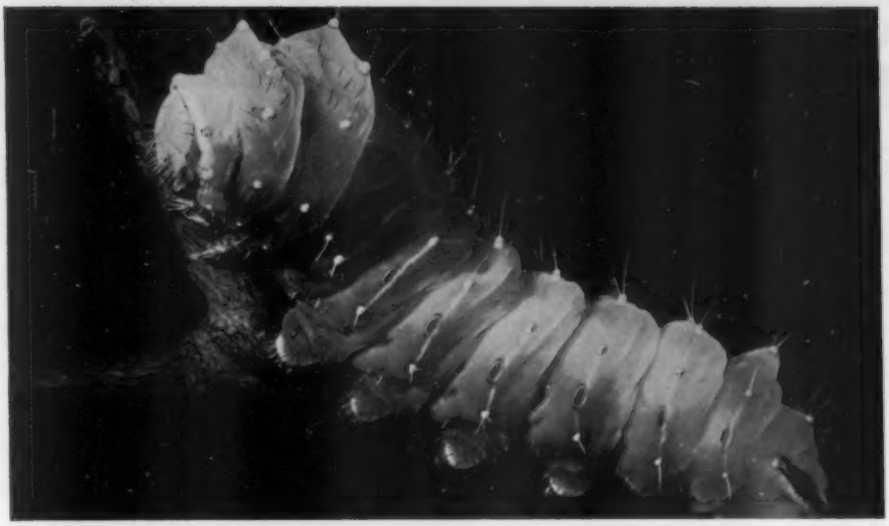
HAEMO-SOL
The Labor-Saving NO-SCRUB Cleaner Developed for Laboratory Glassware, Surgical Apparatus and Instruments
MEINECKE & COMPANY, INC.

Here are eight distinct reasons why **Haemo-Sol** is the preferred cleaner for laboratory glassware.

- Completely Soluble
- Leaves No Residue
- Fully Haemo-Digestive
- Lower Surface Tension
- Scientifically Formulated
- Controlled pH
- Multiple Laboratory Uses
- Greater Economy

for literature and samples write today to:

MEINECKE & COMPANY, INC.
225 Varick St. • New York 14, N. Y.



A new way to kill him

takes 3 years and $1,000,000

You need lots of weapons to fight the 82,000 kinds of insects that cost farmers one billion dollars annually.

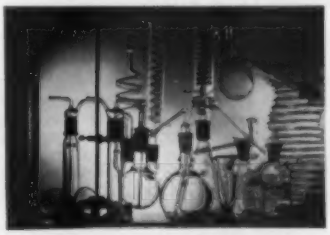
The search for the perfect insecticide goes on continually. And a tricky search it is. A new compound, probably a hydrocarbon, might kill insects but it might also harm crops. Or be toxic to humans.

Finding out generally takes 90% of the estimated million dollars spent in developing a new insect killer. The money goes for initial research, laboratory and field testing, toxicity tests, checking residue and effects on flavor, growth and appearance. If a new control passes these checks, laboratories work out proper formulations.

You can see how vital the laboratory is to modern agriculture. The many firms in this work are turning up new insecticides, herbicides and fungicides at a steady rate.

PYREX laboratory ware is especially helpful in work of this kind. It gives you maximum control over critical sensitivity because its extraordinary chemical stability keeps delicate chemicals safe from contamination. Chemical stability *plus* mechanical and thermal strength match the utility of PYREX ware to a wide range of tasks; make it the most economical laboratory ware you can buy.

You can get exactly the PYREX apparatus you need from your laboratory supply dealer. For accuracy, dependability, economy—standardize on PYREX ware.



Corning Glass Works
Corning New York
Corning means research in Glass

PYREX® laboratory ware
...the tested tool of modern research

Outstanding

McGRAW-HILL BOOKS

AUTOMATIC FEEDBACK CONTROL SYSTEM SYNTHESIS

By JOHN G. TRUXAL, Polytechnic Institute of Brooklyn. *McGraw-Hill Electrical and Electronic Engineering Series.* 694 pages, $12.50

Here is a complete, up-to-date presentation of the methods useful in the design of feedback systems. It is the first advanced and complete treatment of servomechanisms and feedback system design, and places a solid theoretical foundation under the elementary design techniques. The highly developed theories of the design and synthesis of *linear* systems are covered in detail, and the book concludes with an introduction to the analysis and design of *nonlinear* systems. The mathematical methods underlying the theory of feedback systems are developed and utilized as tools in effecting this synthesis. Examples are worked out in detail for each of the theoretical developments presented.

INSTRUMENT ENGINEERING

Volume III: APPLICATIONS OF THE INSTRUMENT ENGINEERING METHOD. In press

By C. S. DRAPER, W. MCKAY, and S. LEES, Massachusetts Institute of Technology. *McGraw-Hill Publications in Aeronautical Sciences*

Made up of examples that use the materials of Volumes I and II for representing instrument engineering situations and finding solutions for the mathematical forms involved. In each example the physical interpretation of the solution is discussed in terms of important factors of the original problems. The examples are based on those in the field of measurement control. The illustrations are chosen so that they demonstrate the application of the instrument engineering procedure pattern to practical problems and also provide immediately available quantitative information on a considerable number of commonly used components and systems.

TRANSMISSION-LINE THEORY

By RONALD W. P. KING, Harvard University. In press

For graduate level courses and reference use, this text presents a thorough treatment on an advanced level of the theory of transmission lines. It deals essentially with radio-frequency transmission lines and with the steady-state problem. The quality of the manuscript is high; the subject is covered with considerable detail; and the text and illustrations are clearly done with great care.

Send for copies on approval

McGRAW-HILL BOOK COMPANY, Inc.

330 West 42nd Street · New York 36, N. Y.

Meetings & Conferences

July

11–17. International Symposium on General Relativity, Bern, Switzerland. (H. A. Barton, International Union of Pure and Applied Physics, 57 E. 55 St., New York 22.)

13–17. International Seaweed Symposium, 2nd, Trondheim, Norway. (ISS, c/o T. Braarud, Blindern, Oslo.)

15–22. Assoc. Française pour l'Avancement des Sciences, Caen, France. (Mlle. Henri-Martin, Secrétaire, 28 rue Serpente, Paris 6e.)

18–23. International Assoc. of Applied Psychology, London, England. (C. B. Frisby, Natl. Inst. of Industrial Psychology, 14 Welebeck St., London, W. 1.)

18–23. International Water Supply Cong., 3rd, London, Eng. (L. Millis, 34 Park St., London, W.1.)

20–28. International Union of Pure and Applied Chemistry, Zurich, Switzerland. (R. Morf, Sec. Gen., IUPAC, Zurich 1.)

23–29. International Soc. of Surgery, 16th cong., Copenhagen, Denmark. (E. A. Graham, 600 S. Kingshighway, St. Louis, Mo.)

25–30. International Anatomical Cong., Paris, France. (G. Cordier, 3 Square Alboni, Paris 16e.)

26–29. American Malacological Union, Staten Island, N. Y. (Mrs. M. C. Teskey, P.O. Box 238, Marinette, Wis.)

28–30. Colloquium on Biochemical Problems of Lipids, 2nd, Univ. of Ghent, Belgium. (R. Ruyssen, St. Jansvest 12, University of Ghent, Belgium.)

August

1–5. International Cong. of Plastic Surgery, Stockholm and Uppsala, Sweden. (J. F. Larsen, 12, Kristianiagade, Copenhagen Ø, Denmark.)

1–6. International Cong. of Biochemistry, Brussels, Belgium. (C. Liebecq, 17 Place Delcour, Liége, Belgium.)

3–7. International Meeting of Neurobiologists, Groningen, Netherlands. (J. A. Kappers, Dept. of Anatomy and Embryology, Oostersingel 69, Groningen.)

5–6. Pennsylvania Academy of Science, University Park, Pa. (K. Dearolf, Public Museum and Art Gallery, Reading, Pa.)

6–7. Linguistic Soc. of America, Washington, D.C. (A. A. Hill, 1719 Massachusetts Ave., NW, Washington, D.C.)

8–10. Inst. of Aeronautical Sciences, Seattle, Wash. (S. P. Johnston, IAS, 2 E. 64 St., New York 21.)

12–17. Canadian Teachers' Federation, Ottawa. (G. G. Croskery, 444 MacLaren St., Ottawa, Ont.)

15–18. American Veterinary Medical Assoc., Minneapolis, Minn. (J. G. Hardenbergh, 600 S Michigan Ave., Chicago 5, Ill.)

15–19. American Institute of Electrical Engineers, Pacific general, Butte, Mont. (N. S. Hibshem, 33 W. 39 St., New York 18.)

15–19. American Soc. of Agronomy and the Soil Science Soc. of America, joint meeting, Davis, Calif. (L. G. Monthey, 2702 Monroe St., Madison 5, Wis.)

15–20. International Dental Federation, 43rd annual, Copenhagen, Denmark. (W. R. Klausen, 1 Alhambravey, Copenhagen V.)

17–24. Australian and New Zealand Assoc. for the Advancement of Science, 31st, Melbourne, Australia. (J. R. A. McMillan, ANZAAS, Science House, 157 Gloucester St., Sydney, N.S.W., Australia.)

(See issue of 20 May for more comprehensive listings.)

A New International Centrifuge

FOR THE

Modern Laboratory

The new INTERNATIONAL MODEL U is more than just a Centrifuge in a cabinet. International's experienced engineering has produced a Centrifuge with years-ahead features and unmatched performance.

You will want to know more about the new aerodynamic guard bowl ventilating system—the new stainless steel interior — the stainless steel auxiliary cover that saves valuable bench space — the electric tachometer — the electric time clock — the unique air-filtering system—the spring-loaded hinge — the new vibration dampening system which results in smooth operation without the "shaker" action of over-flexible mountings — the versatility of 84 interchangeable accessory combinations.

Let us tell you more about this completely new Centrifuge, handsomely designed to fit in with your wall counters and cabinets. Write for Bulletin J explaining all these features in detail.

INTERNATIONAL EQUIPMENT COMPANY

1284 SOLDIERS FIELD ROAD, BOSTON 35, MASS.

PERSONNEL PLACEMENT

YOUR ad here reaches over 32,000 foremost scientists in the leading educational institutions, industrial laboratories, and research foundations in the U. S. and 76 foreign countries — at a very low cost

CLASSIFIED: 18¢ per word, minimum charge $3.60. Use of Box Number counts as 10 additional words.

DISPLAY: Rates listed below—no charge for Box Number. Monthly invoices will be sent on a charge account basis —provided that satisfactory credit is established.

Single insertion	**$19.50 per inch**
7 times in 1 year	**17.50 per inch**
13 times in 1 year	**16.00 per inch**
26 times in 1 year	**14.00 per inch**
52 times in 1 year	**12.50 per inch**

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

POSITIONS WANTED

Associate to Technical Director for Administration. Experience with Research and Development. Box 168, SCIENCE. X

(a) **Bacteriologist** well qualified medical microbiology; Ph.D.; four years' research, university department of medical microbiology. (b) **Parasitologist,** Ph.D.; well trained malariology and related protozoan diseases; five years, on staff research institution. Medical Bureau (Burneice Larson, Director) Palmolive Building, Chicago. X

Biologist, Ph.D. (Zoology), B.S. (Botany), Specializing in Cytology, Embryology, with teaching and research experience, publications, desires teaching position. Box 125, SCIENCE. E.O.W. tf

Mathematical Statistician, broad range of experience; publications. Box 170, SCIENCE. X

M.S., Ph.D. (Biochemistry–Microbiology), 3 years medical school, B.S. (Food Chemistry). At present, technical director medium sized pharmaceutical manufacturer, charge of research and development and control. Interested position with future, pharmaceutical or food industry or research institution. Adaptable, age 35. Box 154, SCIENCE. X

(a) **Pharmacologist;** Ph.D.; 2 years, director of pharmacology, large laboratory; 2 years senior fellow in pharmacology, research institute; seeks directorship, pharmacological research unit; administrative position, pharmaceutical industry. (b) **Biochemist;** Ph.D., Columbia; 10 years experience, two as chief, microbiology branch, army nutrition laboratory; now chief biochemist, 1000-bed hospital; hospital, research, or industrial appointment considered. Woodward Medical Personnel Bureau, 185 N. Wabash, Chicago. X

Virologist; Ph.D., extensive academic and field experience in CNS infections; viruses, immunology, microbiology, tissue cultures, parasitology desires academic–research position. Experienced investigator, teacher, laboratory. Interested fundamental research and teaching undergraduate, graduate levels. Box 164, SCIENCE. 6/17

POSITIONS OPEN

Anatomy Department, Dalhousie University, Halifax, Nova Scotia, Canada. Applications are invited for an assistant and associate professor in the Department of Anatomy. Experience in teaching of Gross Anatomy is essential and a working knowledge of Histology and Embryology desirable. Candidates with an honors degree in medical science or biology will receive special consideration, although a medical degree is regarded as an important asset. Minimum salary for science graduates for position of assistant professor $4,800.00, for associate professor $5,700.00. Salaries above these minima will depend on experience and medical qualifications. Applications to be made to Professor R. L. de C. H. Saunders, at the above address. 5/6; 6/10; 7/8

Biochemist, organic chemistry background, young Ph.D., male or female, familiar with tracer techniques, metabolites isolation, whole animals or isolated tissues. Philadelphia area. September, 1955. Submit minimum salary and qualifications. Research institute. Box 167, SCIENCE. X

POSITIONS OPEN

(a) **Biochemist;** M.S. with technician training; private laboratory, Board Pathologist; university city. (b) **Senior Bacteriologist;** M.S., equivalent experience; 400 bed tuberculosis hospital affiliated important medical school; opportunity continue education; Mid-East. (c) **Biochemist;** Ph.D.; aid in expanding diagnostic laboratory facilities, 150 bed general hospital; supervise technical chemistry procedures, teach technicians and interns; research, publications encouraged; MidEast. (d) **Zoologist;** chairman, university department; professorship; excellent departmental facilities; Midwestern University, enrollment 5,000; $7,000 for nine months. Woodward Medical Personnel Bureau, 185 N. Wabash, Chicago. X

(a) **Biochemical** endocrinologist; research in cortisone metabolism, other medical projects; opportunity faculty appointment; medical center, Midwest. (b) **Physiologist;** university having enrollment 5000; duties: developing research in field of choice, teaching about twelve hours weekly; rank, salary, dependent qualifications; Midwest. (c) **Chemist,** analytical or physical; well known laboratory engaged in practical research; opportunity medical school faculty appointment. (d) **Bacteriologist** qualified microbiology; faculty appointment, liberal arts college; rank: assistant professor; Pacific Coast. (e) **Clinical psychologist;** industrial company; East. S6-2 Medical Bureau (Burneice Larson, Director) Palmolive Building, Chicago. X

Biologist, to work with tissue transplantation and animal genetics; opportunity for personal research; write Director, R.P.M.I., 666 Elm Street, Buffalo 3, New York. 6/10, 17

Chemist, M.S., or Ph.D., interested in mineral metabolism research and trained in isotopes. New York City. Box 171, SCIENCE. X

Coders and Abstractors—Ph.D. or M.S. in Physiological Sciences to cover assignments in world literature on drugs and cardiovascular system. Full or part-time work at home near good medical library. Foreign language knowledge preferred. Box 160, SCIENCE. 6/10

Industrial Pharmacologist. Pharmacologist with industrial experience to direct pharmacological investigations including research, screening program and control procedures in an industrial research laboratory. Middlewest location. Salary commensurate with qualifications and experience. Box 165, SCIENCE. X

Literature Chemist—M.S. in biochemistry with minor in organic chemistry to assist senior scientist in literature searching, abstracting and evaluation of scientific data. Reading knowledge of scientific French and German. Age 24 to 35. Comprehensive benefit program. Send complete information of education and experience. Box 149, SCIENCE. 6/3, 10

Pathologist: To do research pathology and some routine examination of animal tissue in ethical pharmaceutical firm. Location Metropolitan New York. Box 163, SCIENCE. 6/10, 17

Physiologists—Instructor $3600. Associate Professor $6500, to teach Human Physiology eastern university. Time and facilities for research. Mail complete Vita to Box 172, SCIENCE. X

Physiologist—Ph.D. in physiology with interest or experience in neurophysiology to serve as member of research project team in evaluation of scientific data for research and development division of Pharmaceutical firm. Send complete record of education and experience. Box 169, SCIENCE. X

VIROLOGIST

Ph.D. level, background in biochemical aspects of tissue culture; chemotherapy. Prominent North Jersey Pharmaceutical company. Send curriculum vitae Box 166, SCIENCE.

The MARKET PLACE

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

CLASSIFIED: 25¢ per word, minimum charge $6.00. Use of Box Number counts as 10 additional words. Correct payment to SCIENCE must accompany ad.

DISPLAY: Rates listed below—no charge for Box Number. Monthly invoices will be sent on a charge account basis—provided that satisfactory credit is established.

Single insertion	**$19.50 per inch**
7 times in 1 year	**17.50 per inch**
13 times in 1 year	**16.00 per inch**
26 times in 1 year	**14.00 per inch**
52 times in 1 year	**12.50 per inch**

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

BOOKS AND MAGAZINES

WANTED TO PURCHASE . . .

SCIENTIFIC PERIODICALS and BOOKS } Sets and runs, foreign and domestic. Entire libraries and smaller collections wanted

WALTER J. JOHNSON • 125 East 23rd St., New York 10, N. Y.

Your sets and files of scientific journals

are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dept. A3S, J. S. CANNER, INC. Boston 19, Massachusetts

BACK NUMBER PERIODICALS—Bought and Sold

• Tell us what you want?—What have you to offer?

Abrahams Magazine Service Established 1889 DEPT. P, 56 E. 13th ST. NEW YORK 3, N. Y.

WANTED: BOOK MANUSCRIPTS

A publisher with high standards will be happy to read your manuscript on any subject, scientific or general. Intelligent editing, emphasis on book sales, a fair, honest cooperative contract if your work is acceptable. Write, or mail your manuscript directly, without obligation.

GREENWICH BOOK PUBLISHERS, INC.
Atten. MR. INMAN 489 FIFTH AVE.
NEW YORK 17, N. Y.

PROFESSIONAL SERVICES

BOOK MANUSCRIPTS INVITED

Write for Free Booklet SC telling how we can publish your book. All subjects considered. New authors welcome.

VANTAGE PRESS, Inc. • 120 W. 31 St., New York 1
In Calif.: 6253 Hollywood Blvd., Hollywood 28

SUPPLIES AND EQUIPMENT

PROFESSIONAL SERVICES

ANALYSIS OF AMINO ACIDS AND PROTEINS

VITAMINS, MINERALS, FOODS, SPECIAL DETERMINATIONS

SHANKMAN LABORATORIES
2023 SANTA FE AVENUE, LOS ANGELES 21, CALIFORNIA

WISCONSIN ALUMNI RESEARCH FOUNDATION

LABORATORY SERVICES

Project research and consultation in Biochemistry, Chemistry, Bacteriology and Entomology

Mineral determinations including sodium and fluorine • Proximate analyses • Vitamin and amino acid assays • Food chemistry and microbiology • Enzyme investigations

Write for price schedule

WISCONSIN ALUMNI RESEARCH FOUNDATION
P. O. BOX 2059-V • MADISON 1, WISCONSIN

LaWall & Harrisson
Div. S, 1921 Walnut St., Philadelphia 3, Pa.

SINCE 1870

Food & Drug PROBLEMS
PHARMACOLOGICAL · BACTERIOLOGICAL · CHEMICAL

SUPPLIES AND EQUIPMENT

ALBINO RATS

Our mass production methods insure greatest uniformity and consistency

Price list on request

DAN ROLFSMEYER CO. ■ Phone 6-6149
Route 3, Syene Road, Madison, Wisconsin

HOLTZMAN RAT COMPANY

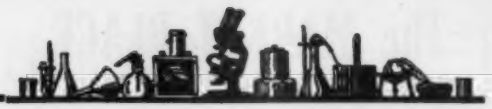
. . . We offer *immediate* delivery of superior albino rats, both sexes, in close age and weight groups.

. . . Our rats conform to Pharmacopoeic standards in regard to Vit. A & D work and have 98% "takes" of tumor implants.

Rt. 4, Box 205 Madison 5, Wisc. Phone: Alpine 6-5573

The MARKET PLACE

BOOKS • SERVICES • SUPPLIES • EQUIPMENT



SUPPLIES AND EQUIPMENT

SUPPLIES AND EQUIPMENT

SPRAGUE - DAWLEY, INC.

PIONEERS IN THE DEVELOPMENT OF THE STANDARD LABORATORY RAT.

All shipments made from our new modern, quarantined colony.

SPRAGUE-DAWLEY, INC. - P. O. BOX 2071

Phone CEdar 3-5318 — Madison, Wisconsin

GERMAN CAMERAS and special equipment for micro- and technical photography or for the hobbyist. Import your own. Save retailers, importers profits. (About 35%.) Pay Postman duty. Examples:—

1955 EXAKTA. The only completely versatile 35mm. camera. With:			
Preset diaphragm Zeiss Tessar	F3.5	$139.	(duty $18.30)
Automatic diaph. Isco Westanar	F2.8	$159.	(duty $19.)
Automatic diaph. Schneider Xenon	F1.9	$195.	(duty $26.)
CONTAFLEX. (1955 Zeiss) Tessar	F2.8	$ 99.	(duty $10.)
RETINA IIIc (Light-scale model) Xenon	F2.0	$112.	(duty $12.)

Similar prices all other famous makes. All new. Latest 1955 production in original factory packing. Parcelpost and insurance included. No other charges. Pre-payment through bank and inspection on arrival guarantees you complete satisfaction before we are paid. Experienced, (and objective) advisory service, (please specify interests and requirements) and price lists by return airmail. All transactions on money-back basis. WORLDPOST. TANGIER, MOROCCO.

---

technicon MOUNTING MEDIUM

the choice coverglass adhesive with *higher refractive index* • *hardens quickly*

Sample? . . . Of course, just write

TECHNICON CHEMICAL COMPANY, INC

POLARIMETER TUBES & ACCESSORIES

for

GENERAL, SEMI-MICRO & MICRO POLARIMETRY
HIGH TEMPERATURE, CONTINUOUS FLOW
& INVERSION TESTS

Write for List PT-14

O. C. RUDOLPH & SONS

Manufacturers of Optical Research & Control Instruments

P.O. BOX 446 — CALDWELL, N. J.

ALBINO RATS* *"From the hand of the veterinarian to research"*

HYPOPHYSECTOMIZED RATS

**Descendants of the Sprague-Dawley and Wistar Strains*

•

HENRY L. FOSTER, D.V.M.
President and Director

THE CHARLES RIVER BREEDING LABS.

Wilmington, Mass.

STAINS

STARKMAN Biological Laboratory

• RARE
• COMMON
Price list on Request
461 Bloor St., W. • Toronto, Canada

FLANDERS RESEARCH FARMS • • • • •

Breeders of

WHITE SWISS and **DBA/2 MICE**

Box 22A, Flanders, New Jersey
Phone Justice 4-7580

C^{14} COMPOUNDS

send for comprehensive list

RESEARCH SPECIALTIES CO

1148 Walnut St., Berkeley 7, Calif.

CONSISTENT RATS & MICE

All animals antibiotic free

BUDD MT. RODENT FARM
CHESTER, N. J.

Breeders of a recognized strain of Wistar rats and W. S. mice

---

GME

714 MARKET PLACE
MADISON 3, WIS.

THE GME TRANSFERATOR MAKES ONE SPECTROPHOTOMETER DO THE WORK OF FOUR!

write for details